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DISCUSSION PAPER NO. 221

Migration and a Small Long-Term Econometric Model of Alberta

by Thomas T. Schweitzer

Un document préparé pour le

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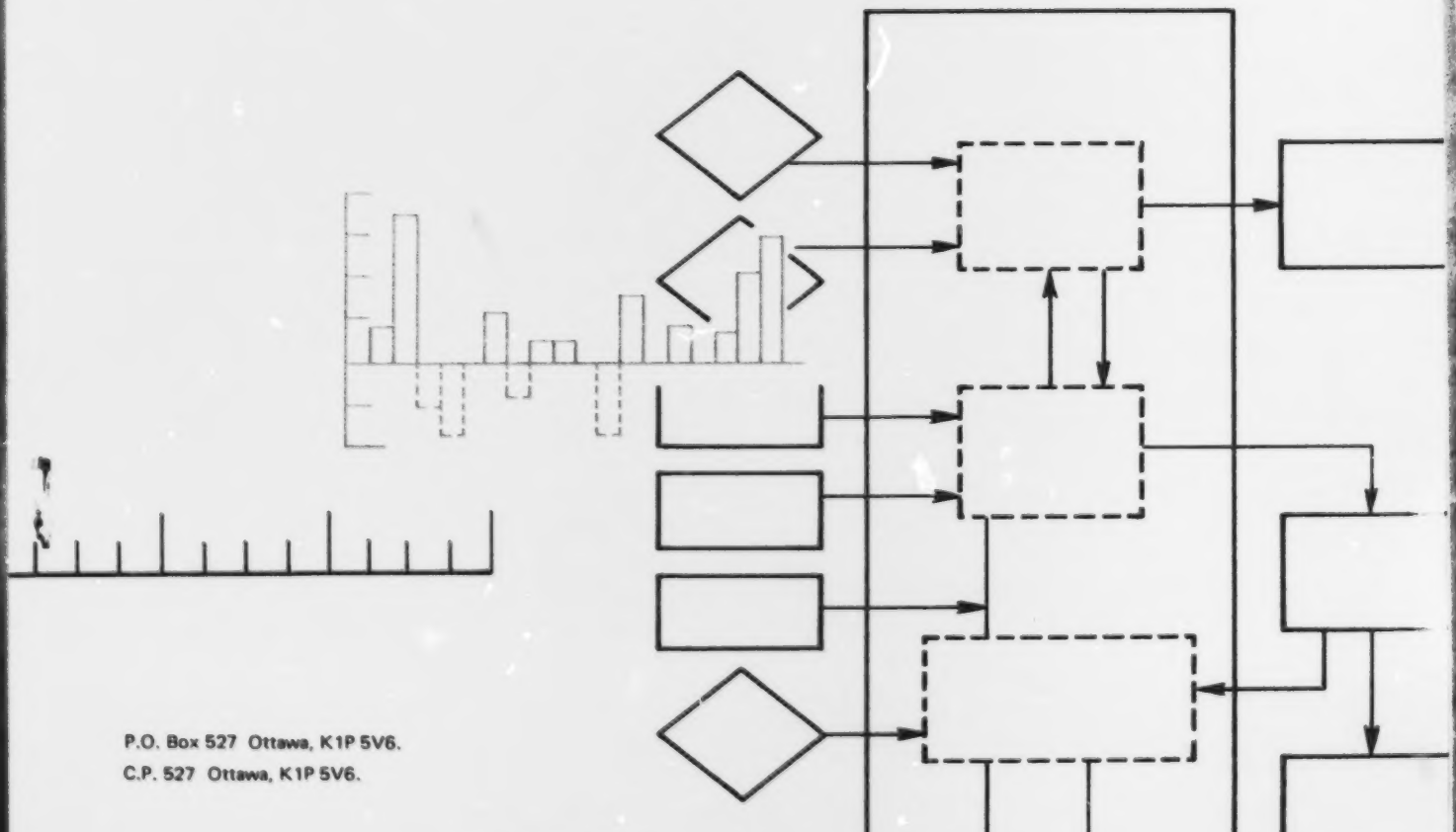

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Résumé

Au cours des 15 dernières années, l'Alberta a connu une croissance économique remarquablement forte et un faible taux de chômage. En outre depuis 1973 son gouvernement a tiré des recettes considérables des ressources naturelles. C'est pourquoi, entre autres, le taux d'immigration de cette province a été très élevé ces dernières années.

Le principal but de cette étude est de voir dans quelle mesure l'immigration continuera. L'auteur cherche à savoir aussi s'il se produira des pertes importantes d'efficacité économique à l'échelon national, du fait qu'une partie des immigrants sont attirés en Alberta par une structure plus favorable des finances publiques et quelle sera l'ampleur des migrations de retour, lorsque l'essor du développement énergétique ralentira.

D'après les résultats obtenus, la migration nette interprovinciale, de 1980 à l'an 2000, pourrait représenter au maximum 676 000 personnes mais on s'attend plutôt que le chiffre ne dépasse pas 194 000. Les retours commencent à l'emporter sur l'immigration en 1995. En l'an 2000, le nombre cumulatif de migrants rentrés chez eux atteint 151 000. Bien sûr, on peut montrer, d'autre part, qu'une certaine partie de l'immigration est stimulée par la structure des finances publiques et qu'elle cause une perte de production réelle à l'échelle du pays. Mais la perte est plutôt modérée. Selon l'estimation même la plus pessimiste,

elle ne serait que de 385,2 millions de dollars (de 1971) en l'an 2000, soit 0,18 % du produit intérieur réel à ce moment-là, selon les projections.

L'auteur a pour deuxième objectif de mettre en lumière une situation économique qui pourrait éventuellement devenir grave pour l'Alberta. Pour répondre à certaines questions concernant l'immigration, nous avons été amenés à traiter, au moyen d'un modèle économétrique non seulement les migrations elle-mêmes, mais l'économie albertaine en général. Nous avons obtenu certains résultats qui sont peut-être intrinsèquement d'un plus grand intérêt que nos constatations au sujet des migrations proprement dites. Ils indiquent notamment que l'économie de l'Alberta semble chanceler très fortement vers la fin des années 80. Le produit provincial réel se stabilise brusquement après 1985 et le taux de chômage dépasse celui du reste du Canada en 1989. Les migrations interprovinciales diminuent fortement au début des années 90, pour se transformer par la suite en émigration nette. Si l'inflation des salaires se montre assez sensible au chômage, le taux de chômage devrait alors se stabiliser au niveau de la moyenne nationale vers 1990, mais dans ce cas les projections montrent que les salaires réels en Alberta ne sont pas plus élevés en l'an 2000 qu'en 1980. Si l'inflation des salaires n'est pas liée au chômage, alors les salaires réels grimpent effectivement, mais le taux de chômage continue d'augmenter après 1990 et dépasse même de beaucoup la moyenne nationale. Somme toute, nos résultats indiquent une croissance beaucoup plus lente de 1980 à l'an 2000

que de 1961 à 1979, et laissent voir que de graves problèmes économiques l'accompagneront. Même la construction de quatre usines de traitement des sables bitumineux, entre 1983 et l'an 2000, ne ferait qu'atténuer seulement les facteurs défavorables de ces tendances sans toutefois renverser complètement ces dernières.

Abstract

In the last 15 years Alberta has achieved remarkably strong economic growth and low unemployment. Moreover, since 1973 the province has received very large government revenues from natural resources. One consequence of these events has been immigration at a very high rate in recent years.

The main purpose of this study is to find out how much more immigration can be expected. In addition, we look at the likely amount of back-migration when the energy boom subsides, and at whether there are likely to be significant losses in national economic efficiency as a consequence of part of the immigration being "fiscally induced".

Our results indicate that over the period 1980 to 2000 a net interprovincial migration of 676,000 can be regarded as the upper limit, with a more likely expected value of 194,000. Net return migration begins in 1995. By the year 2000 cumulative return migration reaches 151,000. Some of the immigration can indeed be shown to be fiscally induced, and to cause loss in real output to the nation as a whole. The loss is rather modest. Even the most pessimistic estimate puts it only $(1971) 385.2 million in the year 2000, or 0.18 per cent of Canada's projected real domestic product at that time.

A secondary purpose of the study is to highlight a potentially serious situation in the Alberta economy. In order to answer

questions about immigration we were led to model econometrically not only migration itself, but also the Alberta economy in general. As it happened, certain results emerged which might be considered of greater intrinsic interest than those relating to migration alone. In particular, the Alberta economy appears to falter very badly by the end of the 1980s. Real provincial product levels off sharply after 1985 and its unemployment rate climbs above the rate of the rest of Canada by 1989. Inter-provincial migration subsides in the early 1990's and turns into net out-migration thereafter. If wage inflation is rather sensitive to unemployment, the unemployment rate would level off at the national average around 1990, but in that case real wages in Alberta are no higher in the year 2000 than in 1980. If wage inflation is not sensitive to unemployment, real wages do go up, but the unemployment rate then continues to rise after 1990, going well above the national level. In sum, our results indicate much much slower growth for 1980-2000 than for the 1961-1979 period, and severe economic problems associated with it. Even the construction of four oil-sand plants between 1983 and 2000 would only mitigate the unfavourable changes in these trends but would not reverse them completely.

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Chapter 1

INTRODUCTION

Alberta's economy has grown at a remarkably high rate since 1965. In the 1961-1965 period it participated in the vigorous expansion of the Canadian economy, though at a rate slightly below the national average. Since 1965 Alberta's growth rate exceeded that of the rest of the country in every single year.

In the eight years 1965-73 i.e., in the period immediately preceding the increase of international oil prices by OPEC, Alberta's mining output (mainly oil and natural gas) increased by over 150 per cent. It has levelled off since 1973. A National Energy board Forecast indicates for Alberta a decline in conventional (non-synthetic) oil productive capacity and a peaking out of gas supply capability in the mid-1980's. Alberta's royalty income showed healthy increases even during the 1970-73 period, but in 1974 royalties doubled and then strong growth continued throughout the decade. Net immigration into Alberta more than tripled between 1971 and 1974 and continued at a high level during the rest of the 1970's. Real labour income per employed person has grown faster in Alberta than in the rest of Canada and the Alberta's unemployment rate has been lower than the national average.

Our original motive for undertaking this study was to investigate the future migration consequences of this prosperity. In particular we wished to investigate:

- how big will the future migration stream be,
- what shape will it take over time,
- will the provincial resource revenues result in a socially wasteful population distribution for Canada.

We found that the model we built to answer these questions could address a wider and more interesting range of issues. In particular:

a) Given a declining productive capacity of conventional oil, will Alberta's economy continue to out-perform that of the rest of Canada?

b) Some academic theorists raised the question: If Alberta continues to receive substantial royalty revenues and if this confers on Alberta residents a "fiscal benefit" (in the sense defined in Chapter 3 of the present study), will the "fiscal benefit" induce a massive migration stream into Alberta? Will this migration reduce labour productivity in Alberta below that in the rest of the country and lead to a lower output for Canada

compared to the one that would prevail in the absence of fiscally induced migration?

c) In case Alberta's growth rate declines, will this cause higher unemployment or a decline in real wages, or both?

d) Can the oil-induced prosperity be sustained, e.g., by constructing a series of oil-sand plants?

e) Alternatively, could the Alberta government prevent the decline of Alberta's growth rate by stimulating manufacturing activity? What would be the economic consequences of such a policy?

f) Many have argued the existence of an interesting mechanism; if the fiscal benefit induces migration to Alberta, the migration will raise land prices. To what extent will the land-price increase in turn act as a brake on migration?

g) In view of the uncertainty about the future of the world oil price, how would alternative oil prices influence Alberta's economic future?

The method adopted in this study is to build an econometric model, grounded in the economic theory of how prices and output are determined in the product and factor markets. Simulations will this model will be the main tool for answering questions. The structure of this study is as follows:

As necessary background, Chapter 2 contains a short history of migration to Alberta and summarizes the relevant literature on migration.

In Chapter 3 we attempt a cross-check on our subsequent econometric results by estimating with a non-econometric technique the fiscally induced migration to Alberta. It also contains an estimate of the possible economic waste caused by such migration.

In order to answer the questions mentioned above we have constructed a small long-term econometric model of the Alberta economy. We describe the theoretical structure of the model in Chapter 4 and report the estimated equations in Chapter 5.

Chapter 6 deals with model simulations designed to answer questions a) to d) above. Question e) to g) will be the subject of a forthcoming study.

Chapter 2

A SHORT HISTORY OF MIGRATION TO ALBERTA AND A SURVEY OF THE RELEVANT MIGRATION LITERATURE

It is not possible to estimate the number of Indians inhabiting the area that is now the province of Alberta previous to European settlement. However, the Indian population of all Canada has been tentatively estimated as 221,000 in the 1600-1780 period [Mooney, J. 1928].

The first European to enter Alberta was Anthony Henday (1754), in the service of the Hudson's Bay Company, bent on extending trade with the Indians. The St. Lawrence based Northwest Company soon followed and a number of trading posts were established. Some of the Northwest Company's employees settled in the West, intermarried with the Indians and became ancestors of the Métis. (The Hudson's Bay Company forbade intermarriage to its employees.) The two trading companies united in 1821 and until 1870 the Hudson's Bay Company governed the area. In 1870 the region was transferred to the Dominion of Canada under the name of Northwest Territories.

After 1870 begins the settlement of southern Alberta, based on ranching. (The first general cattle roundup on the ranges of southern Alberta took place in 1881.) However, the total population of the Northwest Territories, which included the area of what is today Saskatchewan, Alberta, the Yukon and Northwest

Territories as well as much of northern Manitoba, Ontario and Quebec, was a mere 48 thousand in 1871 and 56 thousand in 1881 [Urquhart, M.C. and Buckley, K.A.H., 1965, p. 14].

After the construction of the Canadian Pacific Railway through Alberta (in 1883) the pace of population growth accelerated only slightly. The vast majority of migrants came from the east, so it is not surprising that Manitoba, the easternmost prairie province was settled first, followed by Saskatchewan and then Alberta. Also, the semi-arid climate of Alberta did not attract settlers as long as free or cheap land was available in the sub-humid regions of the Dakotas. Only after the settling of the Dakotas and development of dry farming did wheat growing become economically attractive in Saskatchewan and Alberta [Norrie, K., 1975, pp. 410-427]. However, by 1910 Saskatchewan's population had overtaken Manitoba's, and by 1948 Alberta's had outstripped Saskatchewan's [Statistics Canada, 1956, 1951 Census, Vol. X, Appendix A]. In the earliest census, which records Alberta's population separately (1901), the population amounted to no more than 73 thousand persons.

The following decade witnessed spectacular changes. The availability of free or cheap land, combined with vigorous government publicity in Europe and in the United States, and the recent development of an early-maturing, rust-resistant high quality spring wheat strain (the Marquis) attracted a flood of migrants from the other provinces and from abroad. Between 1901

and 1906 Alberta's population more than doubled, and between 1906 and 1911 doubled again, to 374 thousand. Some 185 thousand native-born Canadians moved to Saskatchewan and Alberta during 1901-11 [Buckley, K., 1962, p. 10] and perhaps 80 thousand of these went to Alberta. The foreign immigration is even more difficult to assess because Canada did not collect statistics on the destination of international migrants. But the sheer size of the immigrant flow into Canada remains astounding, even three-quarters of a century after the event. Table 2-1 compares immigrant arrivals to Canada for the 1901-13 period with the size of Canada's population. For eleven years (1903-13) immigrant arrivals amounted to 2.2 - 5.3 per cent of Canada's population. Let it be mentioned, for comparison's sake, that since World War II there has been only one year in which the number of immigrants surpassed 1.5 per cent of Canada's population (1957, 1.7 per cent). This happened in the year following the Suez crisis and the Hungarian uprising.

The migrants transformed Alberta from a ranch-type agricultural economy to a wheat-growing one. Until the mid-1950s cash receipts from crops usually surpassed those from livestock and products [Statistics Canada, Handbook of Agricultural Statistics Part II, Cat. 21-511, 1967, Table 5].

World War I greatly slowed down migration to Alberta. After the war wheat prices declined sharply. Wheat No. 1 Northern at Fort William fell from 224 cents/bushel in 1918 to 107 cents in 1923

Table 2-1

Immigrant Arrivals and Canada's Population, 1901-1913

	Immigrant Arrivals (Thousand Persons)	Population	Arrivals as Per Cent of Population
	(1)	(2)	(3)
1901	55.7	5,371	1.0
1902	89.1	5,494	1.6
1903	138.7	5,651	2.5
1904	131.3	5,827	2.3
1905	141.5	6,002	2.4
1906	211.7	6,097	3.5
1907	272.4	6,411	4.2
1908	143.3	6,625	2.2
1909	173.7	6,800	2.5
1910	288.8	6,988	4.1
1911	331.3	7,207	4.6
1912	375.8	7,389	5.1
1913	400.9	7,632	5.3

Source (1) Urquhart, M.C. and Buckley, K.A.H., 1965, p. 23.

(2) Statistics Canada, 1951 Census, Vol. X, Appendix A.

[Urquhart, M.C. and Buckley, K.A.H., 1965, p. 359]. The price of wheat recovered in the second half of the 1920s. As Table 2-2 column 5 indicates, net migration to Alberta (calculated as a residual) reflects these fluctuations, showing negative net migration in the 1921-26 period and a positive one during 1926-31. However, net migration never reached the prewar levels. Good quality free land was no longer available and opportunities in nonagricultural occupations were limited. Alberta's economy was still a predominantly agricultural one: the size of urban population overtook the rural one only in the early 1950s, some 30 years after the corresponding change in Canada as a whole [Statistics Canada, 1941 Census, Vol. I, p. 577; 1961 Census, Vol. I, Part I, Cat. 92-536, Table 13].

The Great Depression hit agriculture with extraordinary vehemence. Alberta's farm cash receipts declined from $173 million in 1929 to $71 million in 1933. Not until World War II did Alberta's cash farm receipts in real terms (using the GNE deflator) recover to the level of the late 1920s [Statistics Canada, Handbook of Agricultural Statistics, Part II, Cat. 21-511, 1967, Table 4]. During the 1930s Alberta's population growth dropped to 0.8 per cent per annum -- less than the natural growth of the population (Table 2-3, columns 1 to 4). Alberta experienced persistent negative net migration (-43 thousand), mainly to the other provinces [Buckley, K., 1962, Table 3]. This continued during the 1941-46 period. However, in 1947 an event occurred that was radically to transform the Alberta economy. Oil

Table 2-2

Selected Demographic Variables, Alberta, 1,000 persons

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
						Estimated International Migration			Estimated Interprovincial Migration			Total Estimated Migration			
	Population at start of period indicated	Births	Deaths	Natural Increase (2)-(3)	Total Implied Migration (Net)	In	Out	Net (6-7)	In	Out	Net (9-10)	In (6+9)	Out (7+10)	Net (8+11)	Migration Adjusting Entry (5-14)
1901-06	73														
1906-11	185														
1911-16	374														
1916-21	496														
1921-26	588	76	25	52	-32										
1926-31	608	81	28	53	+71										
1931-36	732	82	28	55	-14	6									
1936-41	773	82	31	52	-29	6									
1941-46	796	95	35	61	-54	5									
1946-51	803	124	34	90	+46	37									
1951-56	939	159	38	121	+63	60	20	+40			-4			+37	+26
1956-61	1,123	184	42	144	+65	53	12	+40			+16			-56	+9
1961-66	1,332	182	47	134	-3	29	32	-3	230	232	-2	259	264	-5	+2
1966-71	1,463	155	49	105	+60	60	24	+36	289	257	+32	349	281	+68	-8
1971-76	1,628	151	55	96	+114	62	26	+35	352	294	+59	414	320	+94	+20
1976-81	1,838	181	60	121	+278	70	18	+52			+151			+203	+75
1976-77	1,838	34	11	22	+50	15	4	+11	85	59	+25	100	63	+36	+14
1977-78	1,911	35	12	23	+50	12	3	+9	89	63	+26	101	66	+35	+15
1978-79	1,984	36	12	24	+51	9	4	+5	92	62	+30	101	66	+35	+16
1979-80	2,059	38	12	26	+58	16	4	+12	105	74	+31	121	78	+43	+15
1980-81	2,143	39	12	26	+67	19	4	+15			+38			+53	+14
1981-82	2,237														

Detail may not add because of rounding.

Source Column 1: Statistics Canada 1951 Census, Vol X, Appendix A, and Catalogue #91-201.
Columns 2,3: Statistics Canada, Catalogue #84-202, 84-204, 84-206 and unpublished.
Column 5: Calculated as residual from Population (t) = Population (t-1) + Births - Deaths + Implied Net Migration.
Columns 6,7,11: 1931-61 unpublished Statistics Canada data, 1961-1980 Statistics Canada Catalogue #91-208.
Columns 9,10: Statistics Canada Catalogue #91-208.

Table 2-3

Selected Demographic Variables, Alberta[1]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
						Estimated International Migration			Estimated Interprovincial Migration			Total Estimated Migration			
	Population annual compound percentage growth	Births	Deaths	Natural Increase (2)-(3)	Total Implied Migration (Net)	In	Out	Net (6-7)	In	Out	Net (9-10)	In (6+9)	Out (7+10)	Net (8+11)	Migration Adjusting Entry (5-14)
1901-06	+20.4														
1906-11	+15.1														
1911-16	+5.8														
1916-21	+3.5														
1921-26	+0.7	2.6	0.9	1.8	-1.1										
1926-31	+3.8	2.7	0.9	1.7	+2.3										
1931-36	+1.1	2.2	0.8	1.5	-0.4	0.1									
1936-41	+0.6	2.1	0.8	1.3	-0.7	0.1									
1941-46	+0.2	2.4	0.9	1.5	-1.4	0.1									
1946-51	+3.2	3.1	0.9	2.2	+1.1	1.9					-0.1			+0.8	+0.6
1951-56	+3.6	3.4	0.8	2.6	+1.3	1.3	0.4	+0.9			+0.3			+1.0	+0.2
1956-61	+3.5	3.3	0.8	2.6	+1.2	0.9	0.2	+0.7			-	3.9	4.0	-0.1	-
1961-66	+1.9	2.7	0.7	2.0	-	0.4	0.5	-	3.5	3.5	+0.4	4.8	3.8	+0.9	-0.1
1966-71	+2.2	2.1	0.7	1.4	+0.8	0.8	0.3	+0.5	4.0	3.5	+0.7	5.1	3.9	+1.2	+0.2
1971-76	+2.5	1.9	0.7	1.2	+1.4	0.8	0.3	+0.4	4.3	3.6	+1.6			+2.2	
1976-81	4.0	2.0	0.6	1.2	3.0	0.8	0.2	+0.6			+1.4	5.4	3.4	+2.0	+0.8
1976-77	4.0	1.8	0.6	1.2	2.7	0.6	0.2	+0.5	4.6	3.2	+1.5	5.3	3.5	+1.8	+0.8
1977-78	3.8	1.8	0.6	1.2	2.6	0.5	0.2	+0.3	4.7	3.3	+1.5	5.1	3.3	+1.8	+0.8
1978-79	3.8	1.8	0.6	1.2	2.6	0.8	0.2	+0.6	4.6	3.1	+1.5	5.9	3.8	+2.1	+0.7
1979-80	4.1	1.8	0.6	1.2	2.8	0.9	0.2	+0.7	5.1	3.6	+1.9			+2.5	+0.7
1980-81	4.4	1.8	0.6	1.2	3.1	0.9	0.2	0.7							

Detail may not add because of rounding.

Source Table 1-2.

1 Columns 2-15 represent average annual numbers as percentages of Alberta's population at the beginning of the period indicated.

was found in the Turner Valley as early as 1914 and some production began in 1924. But it was the discovery of the Leduc field in 1947 which was to have a significant effect on Alberta's future.

In the three years 1947-49 more oil was found in Alberta than in the whole previous history of the province, and major finds were made in 1953, 57 and 59 [Canadian Petroleum Association Statistical Yearbook, 1980, Section II, Table 17]. Major gas discoveries occurred as well, leading to the construction of the Trans-Mountain Pipeline to Vancouver (1953) and the Trans-Canada Pipeline (reached Montreal in 1958). Average personal income, which had recovered from the disastrous decline of the 1930s during the war, stayed above the average Canadian level [Statistics Canada National Income and Expenditure Accounts, Cat. 13-531, Table 36]. Net migration turned positive (+37 thousand) in the first half of the 1950s, but this was due entirely to international migration (+40 thousand). According to Statistics Canada net interprovincial migration remained slightly negative. In the second half of the 1950s another 40 thousand net international migrants increased Alberta's population, but interprovincial migration turned positive as well (+16 thousand) - coming mainly from Saskatchewan.

During 1961-66 Alberta's economy grew at the respectable pace of 6.0 per cent per annum, yet this did not match that of Canada as a whole (6.7 per cent) and of British Columbia next door (7.0 per

cent). In the aftermath of the national slow growth period of 1957-61 and changing immigration policy net international migration to Canada slowed down and tended to concentrate in highly industrialized Ontario and British Columbia. International migration into Alberta turned slightly negative. The same held true for interprovincial migration, net out-migration to British Columbia outnumbering net immigration from the other provinces -- mainly from Saskatchewan, and, to a lesser extent, from Manitoba.

During the 1966-71 period Alberta's real economic growth consistently outstripped that of the rest of Canada. Oil and gas production showed by far the highest growth rate, but, following their lead, all one-digit industry groups except agriculture and forestry recorded stronger growth than in the rest of Canada. The province's net international migration turned positive again. Net migration of Alberta residents to British Columbia (the great magnet of interprovincial migrants) continued, but net migration from the Prairie provinces and even from Central and Eastern Canada became stronger, turning total net interprovincial migration into Alberta's favour.

Migration reached post-World War I peaks after the OPEC crisis of late 1973. The oil price increase of November of that year and subsequent increases sparked renewed interest in Alberta's oil sand resources. The Hudson's Bay Company learned about the existence of the Athabasca oil sands from Indian traders as early as 1719; 35 years before the first white man entered Alberta

[MacGregor, J.G., 1972, p. 35]. Several experimental plants to exploit the sands were built in the twentieth century, but few survived. However, in 1964 Great Canadian Oil Sands Ltd. started construction on a plant which was completed in 1967 and currently produces about 50,000 barrels of oil per day. Early in 1974 construction began on the 130,000 barrels per day Syncrude plant. This very big undertaking employed over 7,500 persons during the peak construction period in 1976-77.

After 1973 international migration began to surpass 10 thousand persons per annum for the first time since the early 1950s. But it was interprovincial migration which showed the most striking increase. While total annual net migration never surpassed an average of 15 thousand in any quinquennium between World War I and 1971, net interprovincial migration rose to 23 thousand in 1974-75 and has been steadily rising since, to 38 thousand in 1980-81. During the construction boom of 1974-77 even net migration from British Columbia turned positive. Migration from the Prairie provinces subsided, and in recent years Manitoba surpassed Saskatchewan as the province of origin. The stream of migrants from Central and Eastern Canada increased, with Ontario predominating. It should be noted that Ontario's real economic growth has been consistently below that of Canada as a whole since 1973.

This short sketch of Alberta's population growth suggests that perceived economic advantage is the main -- though not the only --

motive force that induces voluntary migration. The economic advantage can take various forms: e.g., better or more numerous job opportunities, higher income, lower prices or taxes, better or cheaper government-provided services, higher transfer payments to persons, or a combination of some or all of these. In later chapters we shall attempt to quantify the effect of these economic forces and to make conditional forecasts of future migration to Alberta.

The literature on migration is a vast one. For example a survey of research on internal migration in the United States published in 1975 and covering the period since 1960 cites no less than 251 items [M. J. Greenwood, 1975]. In this chapter we intend to restrict ourselves to the review of that part of the literature that is relevant to the problem at hand: forecasting migration to Alberta with a relatively small annual econometric model.

The great majority of migration studies is based on intercensal cross-section data and attempts to investigate the causes, and to a lesser extent the consequences, of migration. Even cursory inspection of migration data indicate that net migration between regions i and j are usually small resultants of much huger gross migration flows from i to j and from j to i. It is therefore advisable to analyse the two component migration streams separately, it resources permit it [L. A. Sjaastad, 1962; M. J. Greenwood, 1975]. Also, international migration is subject

to much stricter political control than interregional migration, and should therefore be treated separately.

The sizes of populations of i and j are obviously important determinants of migration. The bigger the population of i (P_i), the bigger the number of potential migrants. The bigger the population of j (P_j), the bigger the job market for potential migrants. Almost all migration studies use P_i and P_j in their specifications. Where degrees of freedom are at a premium M_{ij}/P_iP_J is the correct specification [J. Vanderkamp, 1976]. However, when P_j is relatively small but growing rapidly (as is the case of Alberta), while P_i is big and growing more slowly (as is the case of the rest of Canada), P_j will be highly correlated with P_iP_j.

Most modern studies are in the spirit of the human capital formation approach summarized by L. A. Sjaastad [1962]. This view regards migration as an investment decision, by which the potential migrant attempts to maximize the present value of his expected lifetime income differential minus the (monetary and psychological) cost of migration.

For expected lifetime income differentials almost always present differentials are used as proxies. However, S. Bowles [1970] in his study of age-, education-, and race-specific migration calculated lifetime income differentials by using a one per cent annual productivity increase and subjective time preference of six

per cent (obtained by choosing the best fit) over a working life extending to age 65. Usual income concepts are average weekly wages [e.g., S. L. Winer and D. Gauthier, 1982], average annual wage rate [G. Alperovich et. al., 1977], average earned income defined as labour income, military pay and allowances and the net income of unincorporated business proprietors, including farmers [T. J. Courchene, 1970], median money incomes [W. J. Wadycki, 1974] or median family incomes [S. M. Renas and R. Kumar, 1978]. Though income differences frequently appear statistically significant in migration studies, and with the expected sign, they do not invariably do so [see G. Alperovich et. al., 1977 for some recent studies]. One of the reasons for this may be the fact that many studies use intercensal periods as their data base, and the income differential which could cause the migration may, over a five- or ten-year period, get wiped out because of the migration. It is interesting to note that studies using time series almost invariably find income differentials significant [T. J. Courchene, 1970, p. 570; S. L. Winer and D. Gauthier 1982, Table 2-2; R. Mills, 1980, p. 33; A. S. Kwaczek and R. L. Mansell, 1980]. In addition to present income, R. J. Cebula, [1979, pp. 63-66] also includes the income change of the preceding ten years in the expected income.

In cross-section studies, where the degrees of freedom problem is less pressing, researchers often introduce income at i and at j as separate variables [e.g., T. J. Courchene, 1970, p. 562; S. Winer and D. Gauthier, 1981]. In these instances the

(positive) regression coefficient of the income at destination has usually a bigger absolute value than the (negative) one of the origin [T. J. Courchene, 1970; S. L. Winer and D. Gauthier, 1982]. However, particularly in time series studies, the same coefficient has been imposed by using the difference or ratio of the incomes at j and i, with satisfactory results [T. J. Courchene, 1970, pp. 562, 566; D. K. Foot and W. J. Milne, 1980, p. 16; K. Mills, 1980; G. Alperowich et. al., 1977, p. 141; D. Salvatore, 1977, p. 397; A. S. Kwaczek and R. L. Mansell, 1980].

In many cross-section studies nominal wages or incomes have been used. However even in cross-section studies it is preferable to use real incomes to allow for interregional cost-of-living differences [R. J. Cebula, 1978]. Deflation becomes indispensable when time series are used, especially in times of strong inflation. K. Mills [1980] uses a curious deflator: the multiple listing house prices. She argues that the price of tradeable goods ought to be the same across all regions, and house prices are the most important component of nontradeables. The argument ignores the fact that the provincial retail sales tax varies between provinces and this tax certainly does apply to tradeable goods.

Some researchers argue [e.g., K. Mills, 1980] that the spirit of the human capital approach to migration theory requires the use of interregional income differentials rather than income ratios.

However, over time, with rising real incomes, constant income differentials imply decreasing income ratios, and it is reasonable reasonable to assume that, ceteris paribus, a constant real income percentage gain will be necessary to induce a given migration rather than a constant absolute gain. Also, the use of the income ratio becomes mandatory, if we wish to cast our specification in a logarithmic form. Such a form, incidentally, necessitates the analysis of gross migration rather than of net migration, because net migration is frequently negative.

R. L. Mansell and R. W. Wright [1978] argue that net migration is a function of the logarithm of the relative per capita income differential of the two regions involved. They base this

> on the notion that because of capacity limitations in such areas as housing and transportation, there will be a decreased responsiveness of interregional migration to income differentials at high rates of migration. It may also be possible that given differing degrees of risk perception among potential migrants, as the rate of migration increases, the proportion of migrants who have a high risk perception increases and hence the responsiveness of further migration to income differentials decreases.

The second part of the argument may become particularly appropriate when we consider migration between Alberta and the rest of Canada. As the pool of potential migrants from Saskatchewan becomes smaller because of previous migration, bigger and bigger income differentials may be needed to attract migrants from provinces further away.

Even if we assume (as practically all researchers do) that present interregional income differentials are adequate proxies for the discounted lifetime income gain due to migration of employed migrants, the question arises: what is the probability of the potential migrant getting employment. M. P. Todaro [1969] assumes that the migrant at the destination joins the pool of unemployed, and has then the same chance as any unemployed of getting one of the newly created jobs, i.e., his chance Pr is E/U, where E is the change in employment and U the number of unemployed. Of course the value of Pr has to be truncated to lie between zero and unity (or in the case of a logarithmic specification between, say, 0.001 and 1.0) to reflect the probability of earning the prevailing regional income. This model has been applied to Canada by G. Laber and R. X. Chase [1971] and by S. L. Winer and D. Gauthier [1982]. J. R. Harris and M. P. Todaro [1970] use an alternative probability concept. They assume that the migrant joins the labour force and each member of the labour force has an equal chance to get one of the jobs. This means that the migrant's chance is (1-URATE) when URATE is the unemployment rate. Examples of the use of this probability concept in Canada are K. Mills [1980] and A. S. Kwaczek and R. L. Mansell [1980]. It should be noted that both the Todaro and the Harris and Todaro probability concepts were originally developed to deal with migration from rural to urban areas in underdeveloped countries. It is questionable how appropriate they are in the North American context. M. J. Greenwood [1975] quotes data derived from a U.S. Bureau of Labor Statistics survey

covering the March 1962 to March 1963 period according to which white persons giving work-related reasons for moving -- 17 per cent moved because of job transfers, 61 per cent went to take a job and only 22 per cent went to look for a job. (The corresponding figures for nonwhites were 5 per cent, 37 per cent and 58 per cent respectively.) A recent Statistics Canada Labour Force Survey Research Paper [Statistics Canada, 1982, Table 7] gives data on migrants to Alberta and British Columbia in the 1976-80 period. Among the migrants to Alberta giving work-related reasons for moving, 16 per cent moved because of job transfers, 23 per cent to take a job and 61 per cent to look for a job. Among the migrants to British Columbia the corresponding figures were 21 per cent, 38 per cent and 41 per cent, respectively.

A. S. Kwaczek and R. L. Mansell [1980, pp. 5-8] experiment also with 1/URATE as a proxy for the probability of earning the average regional income and report slightly better results than with the use of (1-URATE). R. J. Cebula [1979] suggests that income differentials, historical income growth differentials and unemployment rates entered separately capture adequately the expected income gain.

Higher expected earnings are the benefit of migration which come first to one's mind. Before discussing the other potential benefits we shall survey the principal costs of migration. These can be divided into monetary costs and psychic costs. Both types of costs increase with the distance between origin and

destination, and, indeed, distance is one of the few variables which show up consistently in migration studies as statistically significant and with the expected, negative, sign [M. J. Greenwood, 1975].

Monetary costs include the cost of moving, which increases with distance, first rapidly, then proportionately to distance, and opportunity costs. The latter are foregone earnings due to time spent on travel, job search, learning a new type of work, etc. Opportunity costs increase with distance because information on conditions at the destination is more difficult and/or more expensive to acquire at the point of origin, if the distance is bigger. However, in the case of opportunity costs too, costs do not increase proportionately with distance. In consequence, distance often appears in migration studies in square root form [G. S. Sahota, 1968] or reciprocal form [J. Vanderkamp, 1971].

The psychic costs of migration consist of a) breaking up the household at the point of origin (this is probably independent of the distance of migration) and b) of the suffering caused by the absence from friends, relatives and familiar surroundings. The b) type costs probably rise rapidly with distance towards a assymptote proportional to distance. Even more extreme is the view of R. L. Burford quoted by M. J. Greenwood [1975, p. 405] who maintains that there may be a threshold distance beyond which psychic costs do not increase at all.

> It may, for example, involve little or no additional psychic cost for a native of New York City to move to Los Angeles as opposed to Denver. Both alternatives are remote enough that his separation from family and friends would probably be equally complete.

In any case, the psychic cost caused by the attachment to the point of origin may wear off with the passage of time as new friends are found and psychological adjustment occurs at the point of destination.

Most studies indicate that the migration-reducing effect of distance is much bigger than moving costs alone would justify [e.g., L. A. Sjaastad, 1962]. It is therefore plausible to conclude that it is the psychic cost -- mostly the lack of information -- that acts as the main deterrent. One of the most important sources of information at i about conditions at j are the reports of friends and relatives who have migrated from i to j. Indeed, M. J. Greenwood [1969, 1970] finds that the stock of migrants from i to j has a substantial positive effect on further migration. In a similar spirit a study by D. Salvatore [1977] finds lagged migration from i to j highly significant. However, this finding is also compatible with the interpretation that the other determinants of migration (differentials in income and unemployment) affect migration with a Koyck-type lag. In any case high past migration could well be the consequence of past income differentials, job opportunities, etc.

If lack of information is an important component of the cost of migration proxied by distance, then it becomes obvious that the cost of return migration from j to i is lower than that of new migration from i to j, because the return migrant is familiar with the labour market, and other conditions of region i. According to J. Vanderkamp [1971] this explains why there is a tendency towards increased return migration during periods of high unemployment.

The difference in unemployment rates between i and j has frequently been used as an explanatory variable of migration, but with very mixed results. Often the variables are not significant [T. J. Courchene, 1970, p. 562], or only the unemployment rate of the sending region is significant [same study, p. 568], the significance of the unemployment variable may depend on the choice of the income variable or on the inclusion of some additional variable. On the whole, a high unemployment rate [M. J. Greenwood, 1969, p. 191] at i seems to have a stronger effect on migration than a low unemployment rate at j. The opposite seems to be true for employment growth: here growth at j seems to have on the whole stronger effect than at i [S. L. Winer and D. Gauthier, 1982, Table 2.2, equations V and VI]. An unusual variant is adopted by R. L. Mansell and R. W. Wright [1978]: they use real investment as the proxy for new employment opportunities and obtain a significant positive coefficient.

In addition to the unemployment rate of the individual regions, the economic prosperity of the country as a whole has a noticeable

effect on the size of migration. J. Vanderkamp [1968] and T. Courchene [1970] found that both in- and out-migration is reduced during periods of high unemployment.

The increase in expected earned income is not the only benefit of migration. The important papers of C. M. Tiebout [1956] and G. Tullock [1971] emphasize that the expenditure and tax patterns of various localities differ; and it is therefore possible for the potential migrant to chose the locality that is most advantageous to him individually -- to "vote with his feet". The effect of many types of government expenditures on migration has been studied: welfare payments [R. J. Cebula, 1978; S. M. Renas, 1980; P. M. Sommers and D. B. Suits, 1973], education spending [R. J. Cebula, 1978; S. M. Renas, 1980], intergovernmental transfers [T. J. Courchene, 1970; S. L. Winer and D. Gauthier, 1982], unemployment transfers [E. T. J. Courchene, 1970; S. L. Winer and D. Gauthier, 1982], health services [R. J. Cebula, 1979, all local government expenditures net of welfare [M. J. Greenwood and D. Sweetland, 1972; R. J. Cebula, 1979]. Many of these studies also emphasize that the benefits derived from government expenditures are not costless, and include tax payments as arguments in the migration equations, in particular property taxes [e.g., R. J. Cebula, 1978, 1979].

Disaggregation of government expenditures and revenues is useful because it indicates the importance the migrants assign to these benefits and costs. Unfortunately, time-series analysis does not

permit much disaggregation. K. Mills [1980] investigates the effect of interregional difference of per capita government expenditures minus revenues on provincial out-migration. Her government expenditures concept covers all provincial government expenditures except interest paid on outstanding debt, while the revenue concept consists of personal direct and indirect taxes. It should be noted that K. Mills ignores local taxes and expenditures, even though the distinction between provincial and local expenditures and revenues is somewhat artificial, and varies from province to province. It is curious that K. Mills uses housing prices to deflate government revenues and expenditures -- the same variable she uses for deflating labour income. The government fiscal benefit differential, as defined by K. Mills is usually positive and significant but not invariably so (Quebec and Manitoba display wrong signs).

A. S. Kwaczek and R. L. Mansell [1980] estimate the effect of per capita government real expenditure and real taxes on provincial net migration to Alberta in j/i ratio form. Their expenditure concept includes <u>all</u> government expenditures (all levels of government including hospitals), the tax concept personal income taxes only (p. 4-11 and 5-4). In the case of the Prairie provinces, Quebec, and British Columbia, their government benefit ratio was not significant, in the case of Ontario and of the Maritimes, the results were mixed, but showed the wrong sign. In the aggregate model where only two regions (Alberta and Rest of Canada) are considered, their government benefit variable is

usually significant, but with a negative sign. The authors suggest that this curious result is due to the fact that government services are provided after the arrival of the migrants and thus a large influx of migrants tends to depress per capita government expenditures. Only S. L. Winer and D. Gauthier do investigate the effect of vast unspent rent income of a region on migration.

The Tiebout-Tullock hypothesis suggests that the advantages of a region which is attractive to migrants will be capitalized in higher property values. W. E. Oates [1969] and M. Edel and E. Sclar [1974] suggest that some capitalization takes place, but is not complete. While housing costs are a component of the consumer price index, and their inclusion among the right-hand side variables in addition to deflated income thus constitutes double counting, it may be justified to do so. Covering monthly payments on a high-priced house may be difficult, if imperfect capital markets do not make sufficient allowance for the higher expected income of the migrant. High housing cost appear as significant deterrent of migration in R. J. Cebula [1978]. K. Mills [1980] finds that high house prices in j relative to those in i tend to discourage out-migration from i, but this tendency is not generally true. It does not apply to Ontario and Manitoba, and the coefficients for Quebec and British Columbia are negative, but not significant.

The overwhelming majority of studies reported in this chapter asserts that migration is dependent on the difference between, say, wage rates in Alberta and the rest of Canada, and migration occurs until the difference has disappeared. An alternative hypothesis, developed by T. P. Lianos [1970, 1972] and followed by D. O'Rourke [1972] and B. M. Walsh [1974] assumes that even in labour-market equilibrium there would persist a certain wage-rate differential between the two regions; however if the differential suffers, say, once for all change, this would create a stock of prospective migrants and a migration flow would commence. The flow would continue until the stock is exhausted. In this hypothesis it is the change in the right-hand side variables that is the moving force. This view, though uncommon, has much to recommend it theoretically, and has been investigated our own work.

Up to this point we reviewed the economic characteristics of the potential migrant's origin and destination. Noneconomic characteristics of the potential migrants and of the regions have also been investigated by the literature.

One of the consistent results of the migration literature is the finding that young earners are more likely to migrate than the older ones. This is perfectly consistent with the human capital theory of migration. Let a person, say, 20 years old, have the choice of migrating to a region with a higher expected income, either immediately or at the age 25. If he migrates immediately,

he will receive the higher income for five more years than if he migrates later. What is more, the present value of these five years' income is particularly high, because it is discounted for a relatively short period. The migration- deterrent effect of age is confirmed by T. J. Courchene [1970, p. 564] and M. J. Greenwood [1975a]. Over the next twenty years, the average age of Canada's population will gradually increase, because of the falling fertility rate of the last two decades. Other things equal this will act as a brake on migration.

Education increases information and thus reduces uncertainty. It should therefore have a positive effect on migration. This is borne out by the studies of T. J. Courchene [1970] and A. Schwartz [1973]. The average educational level of Canada's labour force has been increasing and will continue to do so. This will have a positive effect on migration.

Regarding noneconomic characteristics of the region, numerous studies of United States migration indicate migrants' preference for mild climate and sunshine, e.g., R. J. Cebula [1979]; G. Alperovich et. al. [1977]; M. J. Greenwood [1969, 1970]; S. M. Renas and R. Kumar [1978]. In this context it is interesting to note that 15 per cent of recent migrants to British Columbia gave Health/Climate/Scenery as the main reason for move, but the corresponding figure among migrants to Alberta was only 3 per cent [Statistics Canada, 1982, Table 7].

The following main conclusions can be drawn from migration literature about the choice of variables:

1) Migration should be decomposed into interprovincial and international migration.
2) If resources permit, each of the foregoing should be analysed separately as gross in-migration and gross out-migration.
3) The left-hand side variable should be scaled by an appropriate population variable.
4) Per capita real labour income difference between j and i is the single most important independent variable, but ideally we should use per capita income of origin, and of destination, the consumer price index of origin, and of destination as separate variables.
5) The income variables should be weighted by some indicator of the probability of being employed.
6) Refined cost of migration variables rarely work in a satisfactory manner. They may have to be subsumed in the constant term of the migration equation.
7) Percentage employment growth at i and j are more reliable independent variables than the corresponding unemployment rates.
8) Depressed economic activity in the country depresses regional in- and out-migration.
9) Provincial and local taxes and expenditures are important determinants of migration, however no satisfactory variable of the effect of total fiscal policy has been devised. Using real

expenditure minus taxes (per capita) is not quite satisfactory, because it assumes that migrants are not influenced by government deficits or surpluses.

10) There is some indication that high house prices at destination relative to the corresponding prices at the origin have a negative effect beyond that which is reflected in the relative consumer price indexes of the two regions.

11) The overwhelming majority of migration studies deals with migration during intercensal periods. In such cases the problem of simultaneity arises. Interregional income differential may induce migration, but migration in turn may reduce or extinguish income differentials. Welfare payments may attract potential migrants, and actual migrants become voters, who may vote for even higher welfare payments. Simultaneous estimation is indicated in such cases. However, the problem of simultaneity is much attenuated if the data base is in time-series form and the time unit is relatively short -- say a year.

12) There is increasing recognition of the fact that the right-hand side variables will not necessarily act instantaneously on migration. However, dynamics has not been introduced into migration research beyond the use of the lagged dependent variable. This forces a uniform Koyck-type lag structure on all variables. There is room for the exploration of more flexible lag structures.

13) The stock-flow approach of Lianos should be tried as an alternative specification.

Chapter 3

A NON-ECONOMETRIC ESTIMATE OF FUTURE MIGRATION TO ALBERTA AND ITS CONSEQUENCES

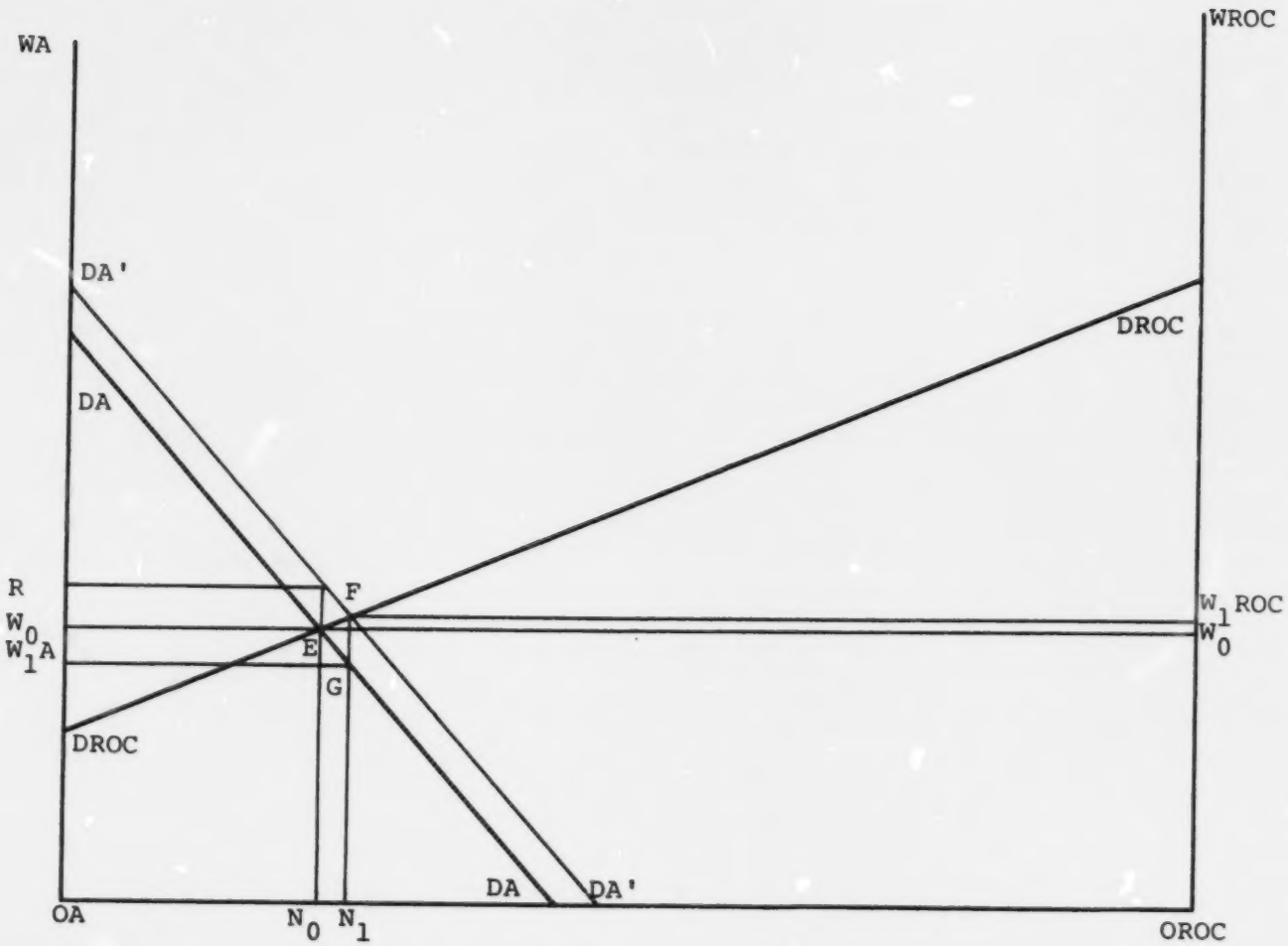
Introduction

The recent large migration to Alberta has attracted the attention of many economists. It has been maintained that, for reasons explained below, this migration could cause a substantial loss of national productivity and output.

Initially we made our non-econometric estimate of migration as a check on our econometric estimate. We used the non-econometric estimate also to calculate a plausible upper bound on the fiscally induced loss. As it turned out, our later econometric estimate of migration is close enough to the non-econometric estimate that our conclusion regarding the fiscally induced loss would not be changed by using the econometric estimates. In consequence, this chapter is the only one that deals with the fiscally induced loss.

Current theories of migration center around the "human capital" approach, which hypothesizes that potential migrants will attempt to maximize their expected discounted life-time utility. (This includes the negative item represented by the financial and psychological costs of migration.) Perhaps the most important single positive component of the gain in utility available from

Chart 3-1



migration is the wage-differential between the origin and destination of the potential migrant. For the discussion of some significant points of the migration problem it will be useful to turn to Chart 3-1 [adapted from Purvis, D.D. and Flatters, F.F., 1980, p. 145]. It represents a highly simplified analysis of comparative statics, but will serve as a starting point for this chapter.

In Chart 3-1 the wage rate is represented on the vertical scale (that of Alberta on the left scale, that of the rest of Canada on the right one) and labour on the horizontal scale. The distance OA-OROC represents the total employment of Canada. OA represents the demand for labour under various wage rates in Alberta, OROC the corresponding demand in the rest of Canada.

It the current wage differential is an adequate proxy for the expected lifetime utility gain and if there are no financial and psychological costs to migration, equilibrium will be established at point E. A nationwide wage rate of W_0 will prevail, and in equilibrium this will be also equal to the marginal productivity of labour in Canada. Labour will be located in the amount OA-N_0 in Alberta and in the amount N_0-ROC in the rest of Canada.

Now assume that Alberta receives resource rents and distributes them equally among the employed residents of the province as a 'fiscal benefit'. Let the amount of the rent share be W_0R. If migrants to Alberta will receive a share of the rent and if they

are indifferent whether they receive their utility in form of wages or in form of fiscal benefits, then migration will set in, and continue until wages plus rent per worker in Alberta equals wages in the rest of Canada. At this point F, employment is $OA-N_1$ in Alberta N_1-OROC in the rest of Canada, the wage rate is W_1A in Alberta, W_1ROC in the rest of Canada, and income per employed person is W_1A+W_0R (=W_1ROC) in Alberta. This new equilibrium implies that the marginal product of labour in Alberta (which equals W_1A) is now lower than the corresponding marginal product in the rest of Canada (W_1ROC). Thus the migration induced by the fiscal benefit results in a 'National Output Loss Induced by the Fiscal Benefit' (NOLIFIB) in output. The loss is represented in Chart 3-1 by the triangle EFG. The area of this triangle is determined by the slopes of DA and DROC and by the size of the fiscal benefit RW_0 (=FG). This is also equivalent to saying that the loss is equal to $(FG*N_1N_0)/2$. Is it likely that NOLIFIB would be substantial? Purvis and Flatters think that "the economic waste might be enormous" [p. 145].

It is easy to estimate the theoretical maximum loss. Let us define

n the number of residents of Alberta, without migration;

x the number of migrants to Alberta (all of whom we shall assume to become employed in Alberta); and

B the total fiscal benefit available for distribution.

If B is distributed equally among all Alberta residents (nonmigrants and migrants), the area A of the triangle EFG will become

$$A = \frac{B}{n+x} * \frac{x}{2}$$

As x grows towards infinity, A asymptotically approaches B/2.

Estimating the Fiscal Benefit

The size of current and future resource revenues of Alberta depend on many factors. Some of the most important are

the international price of crude oil and natural gas, and their time paths;

the wellhead price of oil and gas and their time paths;

the production of oil and gas and their time paths;

the production cost of oil and gas and their time paths;

the Alberta reserves of oil and gas;

the present and future federal and provincial taxation policies.

Each of these factors is surrounded by a huge "halo" of uncertainty, which widens into a "cone" of uncertainty as we look into the future.

Following J. Helliwell [1980, p. 16], we calculated the per capita present value of economic rent stream from oil and gas for

Table 3-1

Per Capita Economic Rents From Oil and Gas, 1982
(Present Values)

	Alberta	Rest of Canada
Total, billion $	294.5	356.0
Population, million	2.772	21.783
Rents per capita (thousand $)	106.2	16.3

Source Economic Council of Canada
Statistics Canada Cat. 11-003

residents of Alberta and of the rest of Canada, based on the Federal-Alberta pricing and tax agreement. We assume no additional oil-sand plants beyond those on stream in 1982. Some pertinent findings are summarized in Table 3-1. All results are discounted present values in thousand 1982 dollars per capita.

In this chapter we are attempting to estimate a resonable upper limit of NOLIFIB. We shall therefore adopt the figures implied by the agreement for the calculations to follow, namely a capitalized asset value of 294.5 billion (1982) dollars. For the purpose of further calculations it is useful to translate this amount into 1971 dollars. Applying the deflator of real domestic product, which stood at 2.829 in 1982 (1971 = 1.0) the Alberta capitalized asset value of oil and gas rents is 104.10 billion (1971) dollars.

In the rest of this chapter we assume that the government will regard this asset as the patrimony of present and future Alberta residents. Such an attitude implies that the value of the asset be preserved and at most the real (inflation adjusted) return be spent, either by distributing the return to Alberta's residents directly, or indirectly via tax cuts, provision of more or better services, subsidies, etc. Any other policy would ultimately erode the value of the asset and redistribute income from future generations to the present one.

Can we put a reasonable upper limit on the real yield of this patrimony, if prudently invested? Table 3-2 is taken from R. Mirus [1980, p. 237] quoting a paper by Ibbotson and Sinquefield. It indicates that in the United States over the very long term (1926-78) a highly diversified portfolio of common stock yielded 6.4 per cent, after inflation -- nine times as much as long-term government bonds. This yield is achieved, however, at the price of a variability of return that is almost four times higher than that of bonds. While up to now the Alberta government has been very reluctant to invest in equities of private corporations [see e.g., A. Glynn, 1981, Tables 1, 4 and 14], it may change its attitude in the future. For instance a portfolio of which 10 per cent is invested in long-term government bonds, 15 per cent in long-term corporate bonds and 75 per cent in common stock, would according to Table 3-2 yield approximately 5 per cent per annum, adjusted for inflation. As a more or less even and regular disbursement of the fiscal benefit would be desirable on economic as well as political grounds, the above-mentioned 5 per cent would probably the maximum realistic achievable yield. It would result in an annual fiscal benefit of 5.205 billion (1971) dollars.

Should the Alberta government find large-scale equity investment in private business uncongenial, the annual fiscal benefit would be smaller, perhaps 1.5 billion (1971) dollars or less. Even this figure may seem very high when we consider that Alberta's <u>total</u> provincial revenue from mineral resources was 4.6 billion

Table 3-2

Return on U.S. Assets 1926-78
(Per cent)

Asset Type	Nominal Annual Return (geometric average)	Inflation Adjusted Return	Standard Deviation of Nominal Return
Treasury Bills	2.5	0	2.2
Long-term Government Bonds	3.2	0.7	5.7
Long-term Corporate Bonds	4.0	1.5	5.6
Common Stock (Standard & Poor)	8.9	6.4	22.2

Source Ibbotson and Sinquefield quoted in Mirus (1980), p. 237.

(current) dollars in 1979-80, i.e., about 2 billion (1971) dollars. However, we must recall that the Agreement assumes very substantial future energy price increases. The projected fiscal benefit is based on the capitalized value of the future rents obtained through these higher future prices.

What will be the effect of the fiscal benefit on net migration to Alberta? This is a difficult question, because we do not know of any precedent to it. It seems plausible, though, that apart from the size of the benefit, its form will also have a major effect on migration. A straight per capita cash grant to all Alberta residents, or to Alberta residents aged 18 and over, would have the highest visibility, and would, ceteris paribus, attract the most migrants. It is unlikely, however, that the Alberta government would ever consider this way of disbursing the fiscal benefit. The arrival of each migrant would dilute the nonmigrant Albertan's share in the benefit. This fact would render the method extremely unpopular among the Alberta electorate and would fan anti-migrant sentiment. A more likely form of a direct grant could take the form of a five years' continuous residence requirement before the disbursement as a qualifying condition. This policy would stimulate migration much less than the unqualified grant. It would attract only those potential migrants who have a job offer from Alberta and hesitate to accept it because the wages are somewhat below the migrant's reservation wage.

An alternative, slightly less visible form of the fiscal benefit would be a reduction in the provincial personal income tax. (The province never had a retail sales tax, therefore that tax cannot be reduced.) This method would have several disadvantages. It would be difficult, if not impossible, to impose a qualifying period, and it would benefit only those who previously paid taxes.

The fiscal benefit could be disbursed in the form of more and/or better public services. This would be a relatively "low visibility" method of distributing the yield of Alberta's natural resources. Most migrants do not have the expertise and the resources to judge interprovincial differences in the quantity and quality of education, health, cultural or transportation services, unless these differences are glaringly big. In practice, federal transfers to the poorer provinces help to prevent their standard of basic services falling below the socially accepted norm.

We should mention one more possible use of the fiscal benefit, a use which could attract almost as many migrants as a direct grant, namely direct or hidden subsidies to selected private businesses or industries. Such subsidies could take the form of loans at low interest rates, preferential treatment in provincial purchasing, lower corporate income taxes, and all the other means invented for helping infant industries. The subsidized industries could offer jobs (even though initially they would not be competitive without the subsidy) and would thus attract migrants.

If the growth of the population would yield sufficient efficiency gains for the subsidized industries to make them eventually competitive even without subsidies, then a policy of subsidization can be defended. If not, the subsidized industries could become a serious burden to their fellow Albertans (who would be deprived of their share of the fiscal benefit) and to the rest of Canada.

Can we get an impression of how Alberta is going to use its fiscal benefit from the way the province has used its resource revenues to date? Until recently thirty per cent of these revenues have been put into the Heritage Trust Fund, where it has been, up to now, mainly invested in low-yielding government or government-guaranteed securities. The current real yield of the Fund is close to zero [Globe and Mail, 8 August 1981, p. B5]. The rest of the revenues has been added to the general revenues of the provincial budget and it is impossible to assign it to specific uses. Some indications of the use are nevertheless discernible. Up to the 1973 OPEC crisis Alberta recorded insignificant provincial and local deficits or surpluses. Since 1973 the province has built up substantial surpluses reaching over $2.0 billion in 1979. Also, in 1979 Alberta paid off the debts of its municipalities. The provincial marginal personal income tax rate of median assessed taxable income, which was about 0.7 points below that of the rest of the country in 1973, has been rising slower than in the other provinces and stood in 1979 3.8 points below that of the rest of the country. In effect a married

taxpayer with two dependent children under 16 years of age and an assessed income of $15,000 in 1980 paid $101 less personal income taxes in Alberta than in Ontario [Canadian Tax Foundation, 1981, p. 75]. Except for subsidized mortgage rates announced in the 1982 budget, there has been not much highly visible distribution of fiscal benefit in Alberta. It seems that the strong migration to the province in the 1974-81 period has been caused by the availability of jobs, the relatively high wages offered or -- much less likely in view of the uncertainties of the timing, size and form it would take --the expectation of <u>future</u> fiscal benefit. This is also borne out by Table 3-3. Here we see that since 1974 Alberta's unemployment rate has been consistently below the Canadian average, while the participation rate and average weekly wages have been consistently above their Canadian average counterparts.

In the rest of this chapter we shall assume that the income equivalent value of the resource rents to Alberta can be estimated as five per cent per annum of the discounted present value of those rents. For the seventy per cent of the rents that are or will be directly distributed (in the form of reduced taxes or "free" government services) this is tantamount to assuming that private citizens, if they chose to invest the patrimony, would obtain a real yield of five per cent. This is the true income value of what they receive. Note that it does not matter if they do not choose in practice to preserve the capital, in effect "spend the principal"; what is at issue here is the proper

Table 3-3

Selected Indicators, Alberta and Canada, 1970-80

	Unemployment Rate (per cent)			Participation Rate (per cent)			Average Weekly Wages (dollars)		
	Alberta	Canada	(1)-(2)	Alberta	Canada	(4)/(5)	Alberta	Canada	(7)/(8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1970	5.1	5.7	-0.6	63.6	57.8	1.100	128.12	126.78	1.011
71	5.7	6.2	-0.5	63.0	58.1	1.084	138.78	137.64	1.008
72	5.6	6.2	-0.6	63.8	58.6	1.089	149.96	149.22	1.005
73	5.3	5.5	-0.2	64.8	59.7	1.085	161.12	160.45	1.004
74	3.5	5.3	-1.8	65.6	60.5	1.084	178.72	178.08	1.004
75	4.1	6.9	-2.8	66.1	61.1	1.082	207.39	203.34	1.020
76	4.0	7.1	-3.1	66.9	61.1	1.095	236.88	228.04	1.039
77	4.5	8.1	-3.6	67.0	61.5	1.089	261.96	249.95	1.048
78	4.7	8.4	-3.7	68.2	62.6	1.089	276.32	275.37	1.047
79	3.9	7.5	-3.6	69.4	63.3	1.096	306.79	288.25	1.064
80	3.7	7.5	-3.8	70.3	64.0	1.098	341.93	320.32	1.067
81	3.8	7.6	-3.8	71.6	64.7	1.107	390.40	355.12	1.099

Source Statistics Canada, Cansim D 769991, 767863, 769990, 767860, 1504, 1495

measurement of the increase to their real income flow attributable to the resource rents. For the thirty per cent of the rents retained in the Heritage Fund the five per cent real return is also a plausible upper limit.

Estimating Migration

Between 1961-62 and 1973-74 net migration into Alberta averaged 6.9 thousand per year. In the census year following the OPEC crisis of late 1973 it jumped to 32 thousand, and has grown since, with minor fluctuations, to 53 thousand in 1980-81. This amounted to an annual net migration somewhat more than 2 per cent of the population of the province at the beginning of each census year.

By way of background we note that Statistics Canada [Cat. 91-520, 1979] has prepared a set of population projections for Canada and the provinces for the 1976-2001 period, under alternative fertility and migration assumptions. The projection which approaches the 1981 actual Canadian population closest is their Projection No. 4. Regarding its interprovincial migration assumptions the Statistics Canada document remarks:

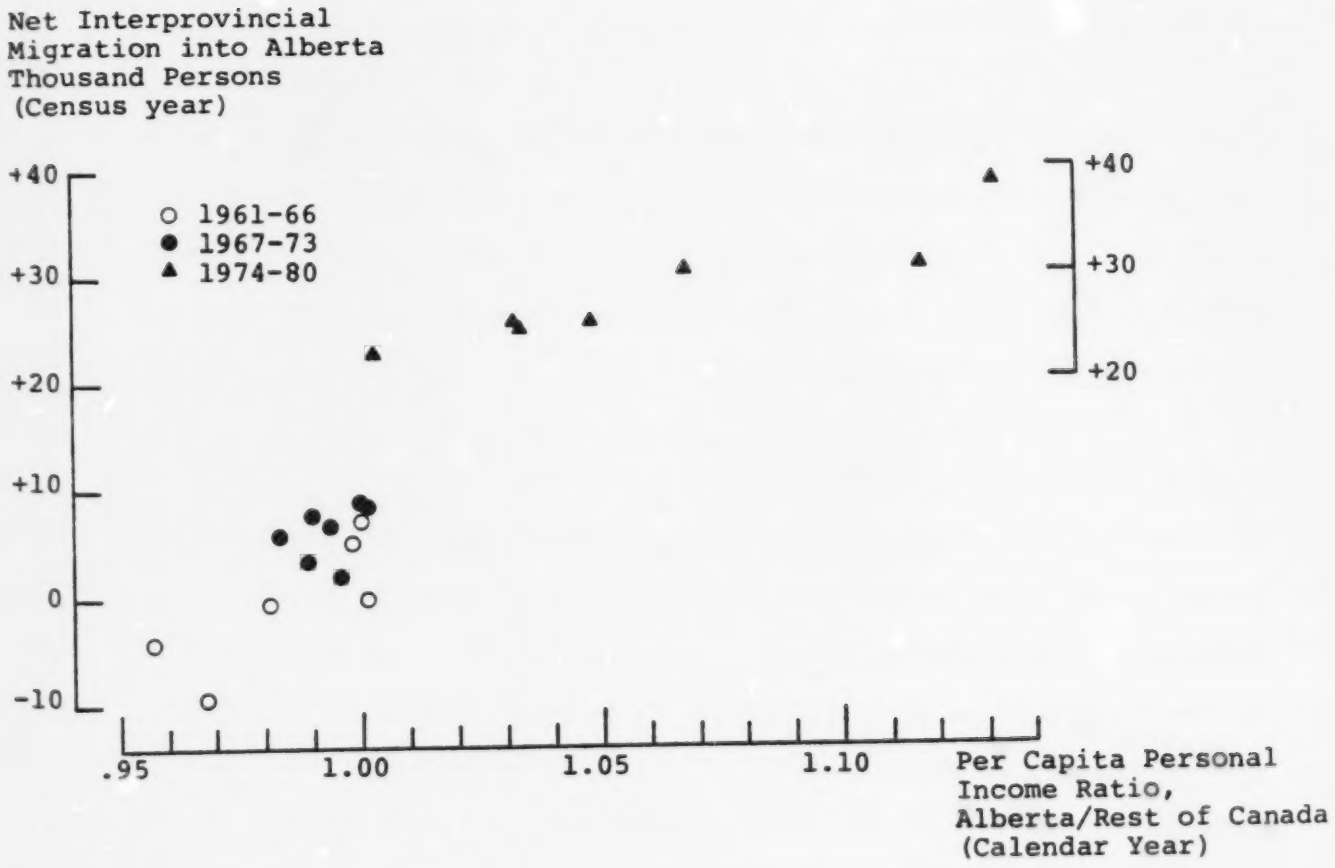
> During the most recent three-year period 1975-76 to 1977-78, there was an average of 385,000 interprovincial migrants each year. This corresponds to an annual rate of about 1.7%. Since 1951, the gross migration rate has fluctuated around this value and it is assumed that this level of gross migration will be maintained in the future. All of the assumptions of interprovincial migration imply a gross migration rate of approximately 1.7 per cent per year [Statistics Canada Cat. 91-520, p. 26].

About the migration into Alberta, the document continues:

> Assumption A. [the assumption adopted in Projection No. 4]. This assumes that the recent levels of out-imigration rates and in-migration proportions, i.e. the 1975-1976 to 1977-1978 averages, are maintained for the duration of the projection period ... [p.271]

Statistics Canada Projection No. 4 yields for the year 2000, a Canadian population of 27,938.5 thousand and an Alberta population of 3,043.6 thousand. This projection takes into account, and projects on the basis of the net migration increase that continued since the major oil price increase of November, 1973. It does not take explicitly into account the possible effect of a fiscal benefit on migration into Alberta. This is not surprising in view of the uncertainties mentioned earlier in this chapter and our lack of knowledge of the form the fiscal benefit would take, nor of the attractiveness the various forms of the fiscal benefit would have on would-be migrants. Nevertheless, we should like to take account of the effect of the benefit on migration. To do so, we shall in the remainder of this Chapter make the extreme assumption that the annual 5.205 billion $71 calculated on page 40 is available to the Alberta government and is distributed as a direct cash payment on a per capita basis to all Alberta residents. Our calculations yield also a fiscal benefit for Canadians outside Alberta. The capitalized value of the economic rent accruing to non-Albertan Canadians is under the Federal-Alberta agreement 356.0 billon or 125.84 billion $71. (Table 3-1). Assuming a 5 per cent net real return on this amount, the fiscal benefit to Non-Albertans is 6.292 billion $71.

Chart 3-2


Net Interprovincial
Migration into Alberta
Thousand Persons
(Census year)
+40
+30
+20
+10
0
-10
1961-66
1967-73
1974-80
+40
+30
+20
.95
1.00
1.05
1.10
Per Capita Personal
Income Ratio,
Alberta/Rest of Canada
(Calendar Year)

Per capita real personal income in 1980 (using the GDP deflator) was 4,841.2 $71 in Alberta and 4,276.5 $71 in the rest of Canada. Assuming 2 per cent compound annual growth, this would yield, in the absence of fiscal benefits, for the year 2000, 7,194 $71 for Alberta and 6,355 $71 for the rest of Canada. We shall now attempt to estimate the effect of the fiscal benefit on migration by two simple methods.

An important point here is that the theory behind Chart 3-1 assumes that migration between Alberta and the rest of Canada continues until the average wage plus fiscal benefit in Alberta equals the average wage in the rest of Canada, and migration ceases when this equality is achieved.

In our Estimate I below migration is a function of the average personal income ratio. In Estimate II we assume that the stock of persons intending to migrate to Alberta is a function of the average personal income ratio. Once this stock of persons has migrated, migration ceases. It is evident that Estimate II is in the spirit of the theory behind Chart 3-1, while Estimate I is more in the spirit of the conventional theory of migration.

1) Migration as a linear function of the income ratio

This method assumes that net migration is a linear function of (personal income per capita in Alberta)/(personal income per capita in the rest of Canada). Chart 3-2 has the average personal

income ratio on the horizontal axis and net interprovincial migration on the vertical one. Regression suggests that since 1974, a one point increase in the income ratio was associated with a migration of 1,054 additional persons. Repeated approximation and linear interpolation between 1980 and 2000 yields a cumulative total of 676 thousand migrants induced by the fiscal benefits, or 33.8 thousand migrants per annum.

2) Equilibrium share of Alberta's population is a function of average personal income ratio

This method assumes that the percentage of Canada's population that desires to live in Alberta is a function of the percentage average personal income differential existing between Alberta and the rest of Canada. This estimate assumes that

$$(3\text{-}1) \qquad \left(\frac{P^A}{P^C}\right)^* = Ay^{\alpha}$$

where P^A = population of Alberta

P^C = population of Canada

y = per capita personal income of Alberta/ per capita personal income of rest of Canada

and the asterisk indicates an equilibrium ratio.

We assume that equilibrium is approached by the usual partial adjustment path.

$$(3\text{-}2) \qquad P^A_t - P^A_{t-1} = \lambda(AP^C_t\, y^{\alpha}_t - P^A_{t-1})$$

We have very few post-OPEC crisis data observations. While strong arguments can be raised that α ought to be less than unity, our regressions indicate α not significantly different from one. We shall, therefore use $\alpha = 1$ in our subsequent estimates. It should be noted that this will tend to bias our migration estimate upward.

We shall use a λ of 0.45. This value implies that after four years, ninety per cent of those desiring to migrate because of a newly arisen and persisting income differential will have actually migrated. We assume the value of λ in order to be able to deduce the value of A, given the regression coefficient estimates in in equation (3.2). A proves to be 0.08056, and is not very sensitive to alternative assumptions of λ (it varies from 0.08496 at $\lambda = 0.25$ to 0.07831 at $\lambda = 0.75$). With A known, it is possible to calculate the equilibrium population ratio of equation (3-1), and given the population of Canada, also the equilibrium population of Alberta.

The Y calculated from actual average personal income data for Alberta and the rest of Canada in 1980 yields an equilibrium population for Alberta of 2193.9 thousand persons (as against the actual population of 2142.6 thousand). If the 1980 average income ratio is augmented by the fiscal benefit, repeated approximation

gives an equilibrium population of 2,830.5 thousand. Thus, using 1980 data, the fiscal benefits would increase the equilibrium population by (2830.5 thousand - 2193.9 thousand) = 636.6 thousand persons.

Similarly, with an all-Canada population of 27,938.5 thousand in the year 2000 (Statistics Canada Projection No. 4) and with the average personal income without fiscal benefit used in the preceding calculations, the equilibrium population of Alberta would be 2,547.8 thousand. With personal income including the fiscal benefit, repeated approximation yields an Alberta equilibrium population of 3,034.4 thousand. Using data for the year 2000, the fiscal benefit would attract (3034.4 thousand -2547.8 thousand) = 486.6 thousand persons. Averaging the number of fiscally attracted migrants (636.6 thousand + 486.6 thousand)/2 yields 561.6 thousand migrants for the 1980-2000 period or 28.1 thousand per annum. This compares with the estimate of 676.0 thousand migrants obtained by Method I.

In order to calculate the national output loss induced by the fiscal benefit, we shall make now a number of simplifying assumptions, each of which will have the effect of overstating the loss.

a) We assume that all the migrants will be of labour force age. This is evidently a pessimistic assumption in the sense that it will increase our estimate of the loss: Alberta Bureau of

Statistics [1979, pp. 97-99] estimates that during the 1971-76 period out of every ten thousand migrants 2,423 were under the age of 15 and 229 aged 65 and over. This yields 2,652 or over 26 per cent not of working age.

b) We assume that all migrants will join the labour force. This again is a pessimistic assumption: even the population of working age contains students, homemakers and other persons who do not wish to join the labour force. Even though the labour force participation rate of Alberta is the highest among all the provinces, it stood at "only" 70.3 in 1980, far from 100 per cent.

c) We assume that all migrants will be employed and furthermore will not "crowd out" any nonmigrant Albertans from employment. This, too, is a pessimistic assumption. Even during the 1974-80 boom period the Alberta unemployment rate never fell below 3.5 per cent.

The results of our estimates for the year 2000 are summarized in Table 3-4.

Referring to Chart 3-1, the loss is equal to the area of the triangle EFG, that is (1,139.5 * 676,000)/2 = 385.2 million $71 for Method I and (1,199.6 * 561,000)/2 = 336.8 million $71 for Method II.

Table 3-4

Fiscal Benefit and Related Variables in the Year 2000

	Alberta		Rest of Canada	
	Method I	Method II	Method I	Method II
Population (1000 persons)	3,719.6	3,567.6	24,218.9	24,370.9
Total fiscal benefit (millions $71)	5,201.0	5,201.0	6,292.0	6,292.0
Per capita fiscal benefit ($71)	1,399.3	1,457.8	259.8	258.2
Advantage in fiscal benefit ($71)	1,139.5	1,199.6		
Fiscally induced migrants (1000 persons)	676.0	561.6		

According to a recent CANDIDE Projection [Preston et al., FCST27.CNTL] the Canadian real domestic product for 1990 is 154.5 billion (1971) dollars. Applying a 3.2 per cent growth rate of real domestic product during the 1990s (Helliwell, 1980, p. 17) we arrive at a Canadian real domestic product of 211.7 billion (1971) dollars for the year 2000. Thus, by heaping pessimistic assumption upon pessimistic assumption, we find that the fiscal benefit induced loss in national output would amount to:

.3852/211.7 or 0.18 per cent of Canadian real domestic product calculated by Method I, or

.3368/211.7 or 0.16 per cent calculated by Method II.

This loss would build up gradually during the two decades and would remain a permanent feature of the Canadian economic scene; however the loss is rather small. Under Method II, the conceptually appropriate one, the loss would therafter be constant. Under Method I, the loss would continue growing, but we doubt that the view is a valid one.

Chapter 4

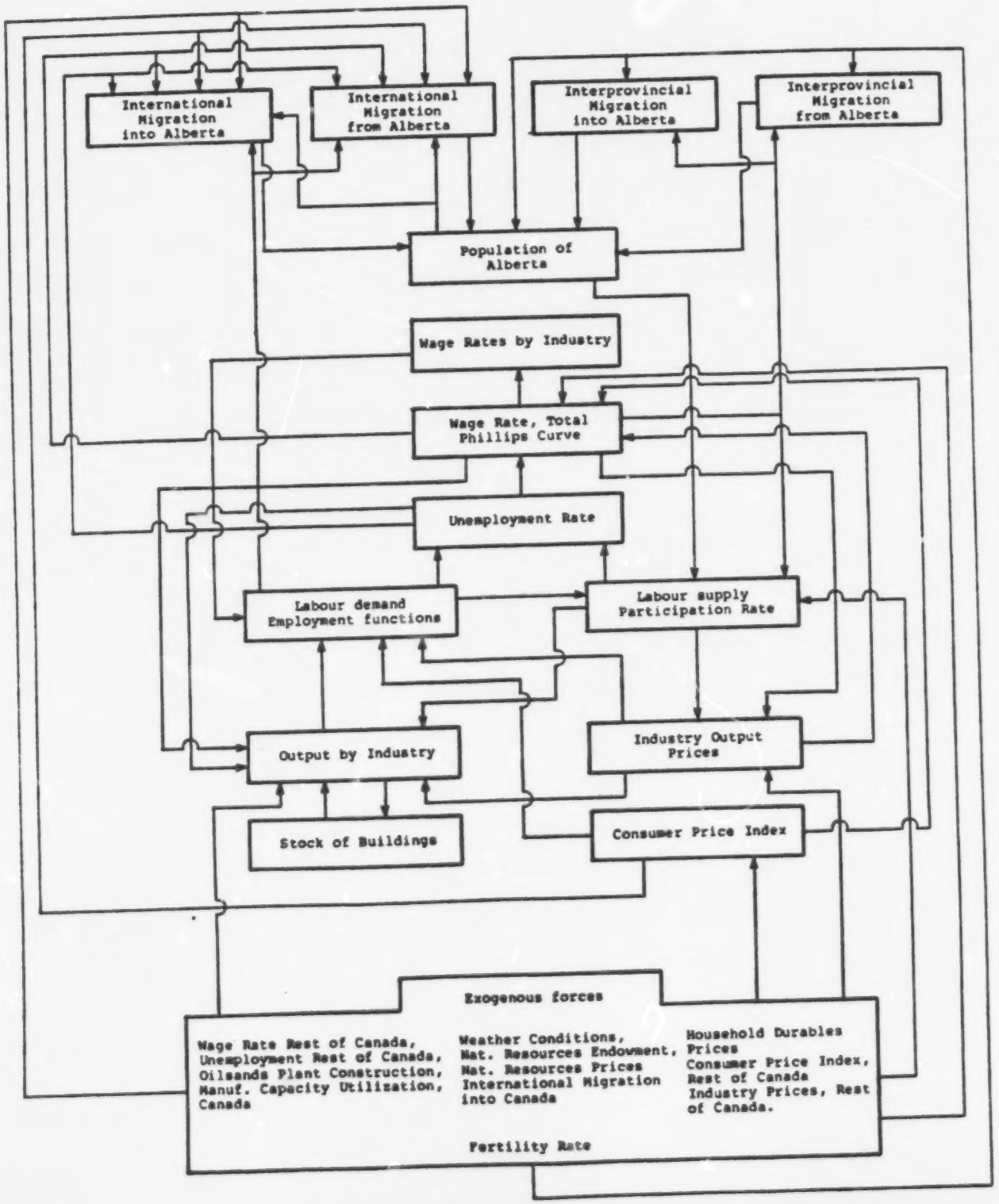
OUTLINE OF THE THEORY AND STRUCTURE OF THE MODEL

In order to investigate some long-term problems of the Alberta economy we have constructed a small neo-classical model of Alberta. We can subdivide it into five sectors: 1) Output, 2) Prices, 3) Labour Demand and Supply, 4) Wages and 5) Migration and Population. We have disaggregated Alberta's economy into five industries, namely Mining (M), Other Primary (OP) (in the case of Alberta this consists predominantly of Agriculture, because Fishing and Forestry are comparatively small), Construction (C), Manufacturing (MF), and all other industries-designated as Services (S).

The output and price equations are based largely on long-run supply and demand considerations in the respective markets. The employment equations are inverted C.E.S. production functions under profit maximization. The labour supply equation incorporates short- and long term forces. In the short run, the aggregate labour force participation rate is influenced by cyclical forces. In the long run the participation tends to rise because the increase of the wage rate relative to the price of household durables induces women to substitute work in the market economy for household work.

Chart 4-1

Flow Chart of the Alberta Migration Model


International Migration into Alberta
International Migration from Alberta
Interprovincial Migration into Alberta
Interprovincial Migration from Alberta
Population of Alberta
Wage Rates by Industry
Wage Rate, Total Phillips Curve
Unemployment Rate
Labour demand Employment functions
Labour supply Participation Rate
Output by Industry
Industry Output Prices
Stock of Buildings
Consumer Price Index
Exogenous forces
Wage Rate Rest of Canada, Unemployment Rest of Canada, Oilsands Plant Construction, Manuf. Capacity Utilization, Canada
Weather Conditions, Nat. Resources Endowment, Nat. Resources Prices International Migration into Canada
Household Durables Prices Consumer Price Index, Rest of Canada Industry Prices, Rest of Canada.
Fertility Rate

Labour supply minus demand determines unemployment. Excess labour demand and prices determine wages via the Phillips curve. The Alberta-Rest of Canada wage ratio and the per capita Alberta-Rest of Canada government natural resource revenues are the main moving forces of migration, following the conclusions of Chapter 2.

1) Real Output or Production (X) plays a crucial role in the model because labour demand is derived from it. For mining we have left output exogenous, because events outside Canada's borders and domestic political forces (federal and provincial) have an overwhelmingly strong influence on production. For construction we have used an approach pioneered by Jorgensen. For all other industries we have developed semi-reduced form equations based on applying conventional long-run supply-demand analysis to the industry in quesiton. It will simplify the industry by industry presentation below if we begin here with a general exposition of how this supply-demand analysis can be used to derive a semi-reduced form equation applicable to ouput of the three industries other than mining and construction.

Demand for the output of the i'th of these industries can in general (exceptions noted below) be taken as a (positive) function of aggregate Alberta income (X) and a (negative) function of the price of its output (PX_i) relative to the price of all competing products (PNX_i).

$$(4\text{-}1) \quad X_i^D = aX^b \left(\frac{PX_i}{PNX_i} \right)^c$$

On the supply side, supply by an individual establishment in the industry ($\hat{X}_i^s$) is a (positive) function of profitability, proxied by the ratio of output price (PX_i) relative to the wage rate (WRT$):

$$(4\text{-}2) \quad \hat{X}_i^s = d \left(\frac{PX_i}{WRT\$} \right)^e$$

If we wish to extend this argument from the establishment to the (provincial) economy as a whole, we must explain the number of establishments in each industry. At our level of aggregation we cannot suppose, for a given labour force, that the supply of establishments is infinitely elastic at minimum average cost, as is expected in standard micro-theory of an industry. Industry supply, designated X_i^s, will be the product of $\hat{X}_i^s$ by the number of establishments. We shall assume that the number of establishments will depend on the number of persons with managerial talent, which in turn is assumed to be proportional to the size of the labour force (LF). Using this assumption and the equation (4-2) for $\hat{X}_i^s$, and defining a new constant d', we obtain

$$(4\text{-}3) \quad X_i^S = d' \left(\frac{PX_i}{WRT\$}\right)^e \quad LF$$

We can now solve (4-3) for PX_i, substitute the result into (4-1), assume that in equilibrium $X_i^D = X_i^S$ and so obtain the equilibrium output of the industry as

$$(4\text{-}4) \quad X_i^* = a^{\frac{e}{e-c}} d'^{\frac{-c}{e-c}} X^{\frac{be}{e-c}} LF^{-\frac{c}{e-c}} \left(\frac{PNX_i}{WRT\$}\right)^{-\frac{ec}{e-c}}$$

or

$$(4\text{-}4a) \quad \left(\frac{X_i}{LF}\right)^* = a^{\frac{e}{e-c}} d'^{-\frac{c}{e-c}} X^{\frac{be}{e-c}} LF^{-\frac{e}{e-c}} \left(\frac{PNX_i}{WRT\$}\right)^{-\frac{ec}{e-c}}$$

or

$$(4\text{-}4b) \quad \left(\frac{X_i}{LF}\right)^* = \alpha\, X^{\beta}\, LF^{\gamma} \left(\frac{PNX_i}{WRT\$}\right)^{\delta}$$

Estimating an equation of the type (4-4b) is in practice very difficult, because total output (X) and the labour force (LF) are highly collinear. If we assume, however, that b does not differ much from unity, (i.e., $\beta \approx -\gamma$), then

$$(4\text{-}5) \quad \left(\frac{X_i}{LF}\right)^* = \alpha' \left(\frac{X}{LF}\right)^{\beta'} \left(\frac{PNX_i}{WRT\$}\right)^{\gamma'}$$

β' and γ' are expected to be positive. Equation (4-5) is in effect a kind of semi-reduced form.

The economy is, of course, never in equilibrium, so we assume that observed scaled output $\left(\frac{X_i}{LF}\right)$ approaches its equilibrium value $\left(\frac{X_i}{LF}\right)^*$ with a lag. One plausible assumption is that $\left(\frac{X_i}{LF}\right)$ approaches $\left(\frac{X_i}{LF}\right)^*$ by the usual partial adjustment of any variable Z to its equilibrium value Z* with $Z = Z_{-1} + \lambda (Z^* - Z_{-1}) = \lambda Z^* + (1-\lambda) Z_{-1}$, where $0 < \lambda < 1$.

This formulation, applied to equation (4-5), yields

$$(4\text{-}5a)\quad \ln\left(\frac{X_i}{LF}\right) = \alpha'' + \beta''\ln\left(\frac{X}{LF}\right) + \gamma''\ln\left(\frac{PNX_i}{WRT\$}\right) + \delta\ln\left(\frac{X_i}{LF}\right)_{-1}$$

In dynamic simulations the use of the lagged dependent variable frequently leads to troublesome error accumulation, therefore we often employed an alternative specification of omitting the lagged dependent variable and using Almon-type lags on the right hand side variables of (4-5):

$$(4\text{-}5b)\quad \ln\left(\frac{X_i}{LF}\right) = \alpha'' + \sum_{o}^{r} \beta''_n \ln\left(\frac{X}{LF}\right)_{t-n} + \sum_{o}^{s} \gamma'' \ln\left(\frac{PNX_i}{WRT\$}\right)_{t-m} \qquad \begin{matrix} n=o\ldots r \\ m=o\ldots s \end{matrix}$$

where the expected signs of $\Sigma\ \beta$" and of $\Sigma\ \gamma$" are positive. Also, in the course of our estimation we used the labour force of the preceding year (LF_{-1}) as the scaling factor instead of LF, in order to reduce the simultaneity of our system. This change does not impair the logic of the preceding argument, and helps to reduce the computer iterations per time period by accelerating the convergence of the model.

Let us now consider in turn the equations for output in each of our five industries.

Mining output (XMA) is assumed to be exogenous. As noted, this is because international political developments, domestic regulation, and export licensing have very strong effects on production.

Output of Other Primary Industries (XOPA) consists mainly of agricultural output. The general analysis described above applies, with one important exception. We suppose that demand is completely elastic at the Rest of Canada (ROC) price. On the supply side the general analysis hold. On a practical point regarding industry price, we note that the price data of the disaggregated components of Other Primary Industries are identical for Alberta and ROC [Conference Board, 1979], so any difference in the aggregate Other Primary Industries price between

Alberta and ROC arises from differences in the composition of output. The appropriate price for this equation is, therefore, the Alberta price PXOPA (which is the ROC price adjusted for the Alberta product mix).

Bearing all of the above in mind, we obtain;

$$(4\text{-}6) \quad \ln \left(\frac{XOPA}{LFA_{-1}}\right)^{*} = \alpha + \beta \ln \left(\frac{PXOPA}{WRTA\$}\right)_{-1}$$

where the asterik indicates equilibrium output. Actual output is assumed to approach equilibrium by the usual partial adjustment, yielding the equation

$$(4\text{-}7) \quad \ln \left(\frac{XOPA}{LFA_{-1}}\right) = \alpha\ \lambda + \beta\ \lambda \ln \left(\frac{PXOPA}{WRTA\$}\right)_{-1} + (1-\lambda) \ln \left(\frac{XOPA_{-1}}{LFA_{-2}}\right)$$

β and λ are expected to be positive and λ less than unity.

The output of the Construction Industry (XCA) is modelled using an approach due to Jorgensen. The industry produces additions to building capital stock, and also replacement for worn-out building stock. Thus XCA is the real value added by the construction industry to gross building capital formation. The theory we follow below applies to net demand, so that XCA cannot be our dependent variable directly. Instead, an appropriate dependent variable incorporating XCA as part of its definition is estimated

as follows: Examining the constant (1971) dollar historical data over the 1961-1979 period we find that capital consumption allowances amounted, on the average, to about 3.1 per cent of the net building capital stock at the end of the preceding year ($K1A_{-1}$). Also, real value added by the construction industry amounted to about 45 per cent of final demand construction capital formation. Therefore, real value added by the construction industry which was devoted to replacement of capital stock amounted to 1.4 per cent (0.45*0.031) of the capital stock. The appropriate dependent variable for net investment demand is the XCA devoted to net addition of construction stock, i.e., XCA - $0.014*K1A_{-1}$.

Following the Jorgensen neo-classical investment model (see e.g., White, D.A. 1974), desired investment demand under profit maximization can be modelled as

$$(4\text{-}8) \quad (XCA - 0.014K1A_{-1})^* = \alpha \left[\left(\frac{PQ}{C}\right)_t - \left(\frac{PQ}{C}\right)_{t-1} \right]$$

where Q stands for real provincial product, P for the provincial implicit deflator and C for the user cost of capital.

As pointed out by White: "not all of the increased capital stock can be put into place immediately. For technical, institutional and economic reasons, changing the volume of capital stock takes time. In any period, the part of current investment

that represents a change in the stock of capital is a sum of the effects of desired changes in the current period and in a number of earlier periods."

$$(4\text{-}9)\quad XCA - 0.014*K1A_{-1} = \sum_{0}^{n} \alpha_i \left[\left(\frac{PQ}{C}\right)_{t-i} - \left(\frac{PQ}{C}\right)_{t-i-1}\right] \qquad i=0\ldots n$$

In our specification Q was replaced by real provincial product excluding construction, P by the corresponding deflator. We also made the strong assumption that the deflator of value added in construction (PXCA) was an adequate proxy for the user cost of capital C. $\Sigma\ \alpha_i$ is expected to be positive.

Manufacturing output in Alberta (XMFA) can be regarded as consisting of two parts: products which are not traded with the rest of Canada, like bread, beer, local newspapers, etc., and traded manufactured goods.

We have data only on manufacturing as a whole, not on traded manufactured goods separately. If we had data on nontraded manufactured goods, equations (4-1) to (4-5b) would apply. The price term corresponding to PNX_i in these equations would have to be the implicit price index of all those goods and services which are competing with Alberta manufactured goods for the Albertans' income. These competing goods have two components: Albertan non-manufacturing output, and imports of goods and services into Alberta. Therefore, the appropriate price concept

corresponding to PNX_i in equations (4-5a) or (4-5b) is a weighted average of Alberta's non-manufacturing industries' deflator and of the goods component of the Canadian Consumer Price Index. We have designated this weighted average as PXNMFTA. Thus, if the Alberta manufacturing output did consist only of nontradables, the appropriate specification would be analogous to equation (4-5), and, using lagged labour force as the scaling factor and designating Alberta's total real output as XA, we should estimate

$$(4\text{-}10a)\quad \left(\frac{XMFA}{LFA_{-1}}\right)^{*}_{UNTRADED} = \alpha \left(\frac{XA}{LFA_{-1}}\right)^{\beta} \left(\frac{PXNMFTA}{WRTA\$}\right)^{\gamma}$$

with β and γ expected to be positive.

However, we have data only on manufacturing as a whole, not on traded and untraded manufactured goods separately. This introduces a complication.

It can be argued that under simple but plausible assumptions the output of tradeable manufactures is a (negative) function of the stock of natural resources per member of the labour force and a (positive) function of the price of manufactured goods relative to the price of resources. Suppose this to be so, and assume that Alberta was originally endowed with a stock S of non-renewable resources. The cumulative output of the mining industry ($\sum_{t=-1}^{-\infty} XMA$)

can be regarded as an acceptable proxy for the using-up of non-renewable resources. Then $S/[\sum_{t=-1}^{-\infty} XMA)*LFA]$ will be an acceptable proxy for the remaining non-renewable resource stock per member of the labour force. Defining PXRESA as the appropriately weighted price of the mining and other primary industry sectors, PXMFA/PXRESA is the relative price of manufacturers to resources output.

For traded manufactured goods we should therefore estimate

$$(4\text{-}10b)\quad \left(\frac{XMFA}{LFA_{-1}}\right)^{*}_{TRADED} = \alpha' \left(\frac{S}{(\sum_{t-1}^{-\infty} XMA_t)*LFA_{-1}}\right)^{\delta} \left(\frac{PXNMFTA}{PXRESA}\right)^{\eta}$$

Adding (4-10a) and (4-10b) and assuming that a logarithmic specification is an adequate approximation, we obtain

$$(4\text{-}11)\quad \ln\left(\frac{XMFA}{LFA_{-1}}\right)^{*} = \alpha'' + \beta'\ln\left(\frac{XA}{LFA_{-1}}\right) + \gamma'\ln\left(\frac{PXNMFTA}{WRTA\$}\right) + \delta'\ln\left(\frac{1.}{(\sum_{t-1}^{-\infty} XMA_t)*LFA_{-1}}\right) + \eta'\ln\left(\frac{PXMFA}{PXRESA}\right)$$

The $\delta'\ln S$ term is subsumed under the constant term α'. This is the specification we have fitted. β', γ' and η' are expected to be positive, δ' negative.

Once again, we shall assume that equilibrium will be approached by either a partial adjustment, reflected by a lagged dependent variable, or with an Almon-type specification of the right-hand side variables.

The output of Service Industries (XSA) consists essentially of non-tradeables, even though certain components like Finance, Insurance and Real Estate may be, to some extent, traded outside Alberta. In consequence the equation of this industry is analogous to that of the non-traded part of manufacturers (4-10a). PXNSTA is the service industry counterpart of PXNMFTA of (4-10a) and the discussion of that concept on page 67 applies here with appropriate changes.

$$(4\text{-}12)\quad \ell n \left(\frac{XSA}{LFA_{-1}}\right)^{*} = \alpha + \beta \ell n \left(\frac{XA}{LFA_{-1}}\right) + \gamma\ \ell n \left(\frac{PXNSTA}{WRTA\$}\right)$$

Here again β and γ are expected to be positive.

Real Capital Stock, Construction (K1A)

This variable is used in the dependent variable in equation (4-9) industry output (XCA), therefore it is necessary to estimate the stock.

By definition, the end-of-year capital stock of year n equals the end of year capital stock of year n-1 plus gross investment

(ICA) in year n minus depreciation (DEPRCA) of the stock during year n. Observe that in this identity gross investment is a final demand component. It includes not only the value added by the construction industry, but also all the intermediate inputs which enter a finished building.

(4-13) $K1A \equiv K1A_{-1} + ICA - DEPRCA$

In our model we do not use the concept of final demand investment. Instead we assume that investment is a constant (estimated) multiple of value added of the construction industry (XCA). Nor do we calculate depreciation directly, but assume that it is a constant (estimated) fraction of the previous year's capital stock. This leads to the estimating equation

(4-14) $K1A = K1A_{-1} + \alpha * XCA + \beta * K1A_{-1}$

Total real provincial product (XA) is by definition the sum of the five industry products and of a small (exogenous) adjusting entry (RPPADJA) which allows for minor inconsistencies in the statistical methods used by the Conference Board when estimating the total and the disaggregated output figures.

(4-15) $XA \equiv XMA + XOPA + XCA + XMFA + XSA + RPPADJA$

2) Consider now the derivation of equations to explain industry prices. Mining prices (PXA), like output, are taken as examples,

and for similar reasons. For other primary industries the price (PXOPA) is determined, as explained above, by industry price in the rest of Canada. Construction prices (PXCA), given our specificaiton at demand, must be regarded as the price at which the industry is willing to supply the output demand. We suppose that the Alberta wage rate would affect this price. While the output required should also, in principle, affect PXCA, the only variable resembling this that worked was a (scaled) dummy variable representing oil-sand plant construction. Thus we regressed

$$(4\text{-}16)\quad PXCA = \alpha(WRTA\$)^{\beta}\left(\frac{DTSPA}{LFA_{-1}}\right)^{\gamma}$$

For manufacturing prices (PXMFA) we do not have the actual Alberta price. It is not collected by any statistical agency. Thus the supply-demand theory developed above to help obtain a semi-reduced form for manufacturing output cannot legitimately be used for price. What we have for manufacturing prices is a weighted average of disaggregated national price indexes for two-digit industries [Conference Board, 1980, p. 23]. Thus the Alberta manufacturing price index differs from that of the ROC because of the differing output mix at the two-digit level. We have therefore estimated the aggregate Alberta manufacturing price equation as the function of the current and previous year's aggregate ROC manufacturing price.

The output of the service industry is assumed to consist entirely of non-tradeables.

In deriving an appropriate equation for PXSA we return to the supply and demand equations in the general industry case, (4-1) and (4-3).

These yield

$$(4\text{-}17)\quad PX_i^* = \left(\frac{a}{d'}\right)^{\frac{1}{e-c}} X^{\frac{b}{e-c}} LF^{-\frac{1}{e-c}} WRT\$^{\frac{e}{e-c}} PNX_i^{-\frac{c}{e-c}}$$

or

$$(4\text{-}17a)\quad PX_i^* = \alpha\, X^{\beta}\, LF^{-\gamma}\, WRT\$^{\delta}\, PXN_i^{\eta}$$

As in the case of equation (4-4b), leading to (4-5), we assumed that b does not differ much from unity, and therefore

$$(4\text{-}18)\quad PX_i^* = \alpha' \left(\frac{X}{LF}\right)^{\beta'} WRT\$^{\delta'}\, PNX_i^{\eta'}$$

where β', δ' and η' are expected to be positive.

The appropriate price is a weighted average of Alberta's non-service industries' deflator and of the goods component of the Canadian Consumer Price Index. We have designated this weighted average PXNSTA.

We apply this general result to the service sector, and as in the case of the output equations we use LFA_{-1} as the scaling factor, to obtain

$$(4\text{-}19)\quad PXSA^* = \alpha'' \left(\frac{XA}{LFA_{-1}}\right)^{\beta''} PXNSTA^{\gamma''} WRTA\$^{\delta''}$$

The industry-specific current dollar provincial products are obtained by multiplying their constant dollar outputs by the corresponding prices (i.e., $X_iA\$ = X_iA * PX_iA$). The deflator of the total provincial product is defined as the ratio of the total current over constant dollar provincial product.

$$(4\text{-}20)\quad PXA \equiv \frac{XMA\$ + XOPA\$ + XCA\$ + XMFA\$ + XSA\$}{XMA + XOPA + XCA + XMFA + XSA + RPPADJA}$$

The Consumer Price Index of Alberta can be assumed to consist of two major components, namely of goods (which are predominantly tradeables) and of services (which are essentially non-tradeables). The goods price component will be determined by the Canadian Consumer Price Index subcomponent for goods, suitably adjusted for the fact that Alberta has not provincial retail sales tax, while the rest of Canada does. We have designated this component as CPIGSTAC. The services price component is determined by the Services industry deflator of Alberta. The weights are those of goods and of services in the Canadian CPI. The series is scaled so as to agree with the Alberta CPI in 1971.

(4-21) CPIA = [0.6033 * CPIGSTAC + 0.3967 * PXSA] * 0.996477

3) Labour demand (E) is a derived demand, calculated separately for each of the five industries, using inverted C.E.S. production functions under profit maximization. Following Adams, F.C. et al [1975], the equations are:

$$(4\text{-}22)\quad \ln E_i^* = \alpha + \beta \ln X_i + \gamma \ln (WR_i\$/PX_i) + \delta\ TIME \qquad i=1...5$$

where E* is equilibrium employment, X is real output, WR$ the wage rate, PX the price of output and TIME a linear time trend. The expected signs of the coefficients are positive for β, negative for γ and δ. For modelling the actual employment we applied the usual partial adjustment model or the Almon-lag technique.

Total employment (ETA) is the sum of the five industry employments:

$$(4\text{-}23)\quad ETA \equiv \sum_{i=1}^{5} E_i A$$

Labour supply is given by the product of labour force source population (POP15+) and the participation rate (PARTR). The participation rate displays two kinds of changes: short-term cyclical fluctuations and a long-term rising trend.

Differing hypotheses exist regarding the effects of business conditions on the participation rate [see e.g. S. Ostry and M.A. Zaidi, 1979, pp. 72-74, M. Gunderson, 1980, pp. 53-54, P.J. Kuch and S. Sharir, 1978, pp. 112-120]. One school of thought emphasizes that a high unemployment rate tends to discourage unemployed persons of labour force age from searching for work and results in their dropping out of the labour force (the "discouraged worker effect"). An alternative view propounds that if the chief breadwinner of a household loses his job, this will result in the other members of the household entering the labour force in order to attempt to make up for the income loss (the "additional worker effect"). The relative importance of these alternative hypotheses is an empirical question which we shall attempt to answer in the next chapter. The introduction of the unemployment rate or its counterpart, the employment rate, into the participation rate equation introduces an identification problem, which is discussed in Appendix 4-A of this chapter.

Apart from the short-term fluctuations, the Alberta labour force participation rate has displayed a rising trend during the sixties and seventies. In this respect it resembles the participation rate of Canada as a whole, which shows the same tendency. As pointed out by Ostry and Zaidi [1979, p. 33], the main source of the nation-wide increase in the participation rate was the sharply rising female participation rate; the male particiption rate changed little.

Several plausible hypotheses can be made about the rising female participation rate. In particular, it has been pointed out long ago [Long, C.D., 1958, p. 123-133] that smaller families lead to less need for work in the home. The total fertility rate in Alberta has declined from 4.267 in 1961 to 1.972 in 1979. The number of births showed no rise at all during this period, even though Alberta's population about doubled. It follows that one of the important forces which was keeping women traditionally out of the labour force, namely giving birth and caring for young children in the home, was diminishing during the period under discussion.

An alternative hypothesis is based on the consideration that domestic appliances increase the productivity of the home-maker's activity. Since this idea, though rather obvious, does not appear to have been treated in the literature, an exposition of the theory behind it is given in Appendix 4-B. There it is shown that when the wage rate rises relative to the price of domestic appliances (WRTA$/PFCDH20), as it did during our sample period, women are more likely to substitute capital equipment (in the form of domestic appliances) for their labour at home. They obtain the equipment in part by using their labour in the market instead of the home.

Beside these two relatively easily quantifiable forces which are conducive to raising the female participation rate, there occurred during the sixties and seventies a whole host of changes in public

mores and attitudes towards women in the labour force, which we cannot express in numerical terms but which can be proxied by a time trend. One of these changes was the effort on part of the various levels of government to reduce discrimination in the hiring, promotion and remuneration of women. The example set by the governments had also some spill-over effect into the private sector. Another relevant change was the substantial increase of single-earner families with female heads, due to the increase in divorces and separations.

Thus a reasonable specification of the Alberta participation rate (PARTRA) regresses it on (a suitable transformation described in Chapter 5 of) the wage rate relative to the price of domestic appliances (WRTA$/PFCDH20), on the weighted birth rates of the most recent five years (WBIRTHSRA), on the time trend (TIMEA) and on the employment rate (ETA/POP15+A). The coefficient of the employment rate cannot be estimated directly, for identification reasons, as explained in Appendix 4-A. The Appendix also describes the correct way to obtain the coefficient, which then has been imposed on the following equation:

$$(4\text{-}24)\quad PARTRA - \beta(ETA/POP15+A) = \alpha + \gamma(WRTA\$/PFCDH20) + \delta(WBIRTHSRA) + \eta TIMEA$$

Labour demand and supply determine unemployment (UA) and the unemployment rate (URATEA)

$$(4\text{-}25)\quad URATEA \equiv \frac{LFA - ETA}{LFA}$$

4) The Alberta-wide wage rate (WRTA$) is calculated by the Phillips-curve specification i.e., the rate of change of wages is a function of excess labour demand and of price inflation. We used the reciprocal of the unemployment rate as indicator of excess labour demand. We assume that when striking the wage bargain, workers are thinking in terms of the consumer price index (CPIA), while employers are consider whether the price of output permits the wage increase. We constructed a "hybrid price" inflation rate ($\dot{PHPA}$) which is the arithmetic average of the inflation rate of the Consumer Price Index ($\dot{CPIA}$) and of the provincial output deflator ($\dot{PXA}$).

$$(4\text{-}26)\quad \dot{WRTA\$} = \alpha + \beta \frac{1.0}{URATEA} + \gamma \dot{PHPA}$$

The expected signs of β and γ are positive, with γ non-significantly different from unity.

The industry-specific wage-rates were originally assumed to be functions of the Alberta overall wage-rate and of indicators of industry-specific labour-market tightness, however no significant indicator of this sort was found. Finally we reluctantly specified the ratio of the industry specific wage rate ($WR_iA\$$)

and the Alberta-wide wage rate (WRTA$) as a function of its own lagged value.

$$(4\text{-}27)\quad \frac{WR_i A\$}{WRTA\$} = \alpha \left(\frac{WR_i A\$}{WRTA\$} \right)^{\beta}_{-1}$$

We employed the Zellner seemingly unrelated regression technique under the restriction that the sum of the wage bills of the five industries equal the total Alberta wage bill, i.e.

$$(4\text{-}28)\quad WRTA\$*ETA \equiv \sum_{i=1}^{5} (WR_i A\$*E_i A)$$

The restriction implies that one equation in the estimation process has to be suppressed. In this instance we suppressed the wage equation for services. The services industry is by a wide margin the biggest industry in our five-industry disaggregation; it accounts for approximately sixty per cent of total provincial product. We judged that it would cause relatively the least trouble if we let it absorb the errors and shortcomings of our wages sector.

5) The literature review of Chapter 2 suggests that it is advisable to disaggregate total net migration to Alberta (MIGTNA) into four gross movements

1) International migration into Alberta (MIGFIA)
2) International migration from Alberta (MIGFOA)
3) Interprovincial migration into Alberta (MIGPIA)
4) Interprovincial migration from Alberta (MIGPOA)

Total international migration into and out of Canada is assumed to be exogenous. We have attempted to model Alberta's share of these two migration streams.

As a starting point it may be convenient to assume, that ceteris paribus international migrants would settle in Alberta and in the Rest of Canada in the same proportions as the total population of the two areas in the previous year.

$$(4\text{-}29)\quad \frac{MIGFIA}{MIGTIC-MIGFIA} = \frac{POP15+A}{POP15+R}_{-1}$$

where MIGTIC is total gross international migration into Canada.

A plausible improvement on (4-29) might be the hypothesis that the ratio would be modified by the wage ratio of the two receiving areas:

$$(4\text{-}30)\quad \frac{(MIGFIA/POP15+A_{-1})}{[(MIGTIC-MIGFIA)/POP15+R_{-1}]} = \alpha \left(\frac{WRTA\$}{WRTR\$}\right)^{\beta}$$

Here the actual wage ratios would act as proxies for expected incomes.

Following Todaro, we might further imporve the expected wage concept by multiplying the actual wage by the probability of obtaining a job. A simple but convenient way to proxy such a concept is to multiply the prevailing wage rate by the employment rate. If we denote the left-hand side of equation (4-30) as RMIGFIAPC1, this would lead to

$$(4\text{-}31)\quad \text{RMIGFIAPC1} = \alpha_1 \left(\frac{\text{WRTA\$ (1-URATEA)}}{\text{WRTR\$ (1-URATER)}}\right)^{\beta_1}$$

If we further assume that it is the expected <u>real</u> wage rate ratio that influences migration, then (4-31) would change to

$$(4\text{-}32)\quad \text{RMIGFIAPC1} = \alpha_2 \left(\frac{\text{WRTA\$ (1-URATEA)/CPIA}}{\text{WRTR\$ (1-URATER)/CPIR}}\right)^{\beta_2}$$

Some experts on migration maintain that expected real income is the single most important economic force influencing migration, while others are of the opinion that job opportunities play an equally or more important role. We might attempt to proxy job availabilities by the growth of non-agriculture employment in Alberta (ENOPA) and in the rest of Canada (ENOPR), where ENOPA is defind as total employment in Alberta (ETA) minus employment in

other primary industries (EOPA) ENOPR is defined correspondingly. This would yield

$$(4\text{-}33)\quad RMIGFIAPC1 = \alpha_3 \left(\frac{WRTA\$\ (1\text{-}URATEA)/CPIA}{WRTR\$\ (1\text{-}URATER)/CPIR}\right)^{\beta 3} \left(\frac{ENOPA/ENOPA_{-1}}{ENOPR/ENOPR_{-1}}\right)^{\gamma 3}$$

Returning now to equation (4-30) we should consider that the economic attractiveness of a region does not consist solely of a high wage rate prevailing there. The Alberta government receives much more revenue from the area's natural resources than do the provincial governments of the rest of Canada from theirs. Migrants may not know in what form and at what time these government natural resource revenues will be transferred to the residents of each area; nevertheless the mere existence of such revenues (GRNRA$) may influence their location decision. This hypothesis would lead to the specification

$$(4\text{-}34)\quad RMIGFIAPC1 = \alpha_4 \left(\frac{WRTA\$ + (GRNRA\$/(POP15+A)_{-1})\theta}{WRTR\$ + (GRNRR\$/(POP15+R)_{-1})\theta}\right)^{\beta 4}$$

which can be conveniently approximated by

$$(4\text{-}34a)\quad RMIGFIAPC1 = \alpha_5 \left(\frac{WRTA\$}{WRTR\$}\right)^{\beta 5} \left(\frac{(GRNRA\$/(POP15+A)_{-1}}{(GRNRR\$/(POP15+R)_{-1}}\right)^{\delta 5}$$

Such a specification would assume that migrants are indifferent about the form and timing of natural resource revenue disbursments.

Alternatively we might assume that this is not so, but that different uses of the provincial natural resource revenues could have differing effects on migration and try to model this in more detail. First of all, in the case of Alberta we know that these revenues enabled the provincial government to avoid imposing a provincial retail sales tax - Alberta is the only province without such a tax. The consumer Price Index includes the provincial sales tax; thus Alberta's price index is lower than it would be in the presence of such a tax.

Second, Alberta's natural resource revenue enables the province to keep its personal income tax rates lower than it would be in the absence of oil and gas revenues. Having calculated the marginal income tax rate at median taxable income (ITRA), we might expand equation (4-30) by using the real disposable income ratio.

$$(4\text{-}35)\quad \text{RMIGFIAPC1} = \alpha_6 \left(\frac{\text{WRTA\$ (1-ITRA)/CPIA}}{\text{WRTR\$ (1-ITRR)/CPIR}} \right)^{\delta 6}$$

Third, if we assume that the size and pattern of government expenditure expresses the preference of the electorate, per capita government expenditure may also attract migrants by providing better administration, education, health services, crime

prevention etc. This could be proxied by per capita provincial, local and hospital government expenditures excluding interest payments (PLHEXTA$). If we designated the right-hand term of (4-35) as RDWR, introduction of this variable would lead to

$$(4\text{-}36)\quad RMIGFIAPC1 = \alpha_7 (RDWR)^{\beta_7} \left(\frac{PLHEXIA\$/(POP15+A)_{-1}}{PLHEXIR\$/(POP15+R)_{-1}} \right)^{\eta_7}$$

This specification would assume that migrants are not influenced by the unspent part of the natural resource revenues. Equation (4-36) can be further expanded by assuming a reasonable real return of say, two per cent on the assets of the Alberta Heritage Fund and adding the per capita share of this return to WRTA$.

The possible specifications of Alberta's share of gross international out-migration from Canada (RMIGFOAPC1) are analogous to those of the in-migration. Of course in the case of in-migration the expected signs of β, γ, δ and η are positive, while in the case of out-migration we expect negative signs.

After considerable experimentation with the various income concepts of equations (4-30) to (4-36), we chose (4-33) as our preferred specification.

We also experimented with specifications (4-30) to (4-36) in the cases of gross interprovincial migration to and from Alberta (MIGPIA and MIGPOA respectively). With this modification the

migration streams are standardized by the (lagged) population of the area of origin. The left hand side variables are, therefore, $MIGPIA(POP15+R)_{-1}$ and $MIGPOA/(POP15+A)_{-1}$.

In the case of the interprovincial migration equations our preferred specification was (4-34a), but further augmented by using the Canadian manufacturing capacity utilization rate as an additional right-hand side variable. It should be recalled from our summary of the migration literature (Chapter 2) that favourable business conditions have a stimulating effect on migration in both directions.

As pointed out in Chapter 2, and alternative hypothesis suggests a different specification for equations of interprovincial migration: namely one in which the change of the right-hand side variables of equations (4-30) to (4-36) explain migration. We have estimted such alternative equations and the results are reported in Chapter 5.

Total net migration into Alberta (MIGTNA) equals international migration into Alberta (MIGFIA) minus international migration from Alberta (MIGFOA) plus interprovincial migration into Alberta (MIGPIA) minus interprovincial migration from Alberta (MIGPOA):

(4-37) $MIGTNA \equiv MIGFIA - MIGFOA + MIGPIA - MIGPOA$

Alberta's population aged 15 and over (POP15+A) equals the previous year's population multiplied by (1+POPNGA) where POPNGA is the (exogenous) natural growth rate of the Alberta population aged 15+, plus KMIGA times MIGTNA, where KMIGA is the (exogenous) share of persons aged 15+ among the migrants.

$$(4\text{-}38)\quad POP15+A = POP15+A_{-1}\ (1 + POPNGA) + (KMIGA)\ MIGTNA$$

Appendix 4-A

Technical Aspects of Estimating the Participation Rate Equation

Our original intention was to regress directly the participation rate on the employment rate and on other independent variables. Query: is this procedure legitimate? In this Appendix we shall use the following notation:

e = employed/working age population

ℓ = labour force participation rate $(e + u)$

u = unemployed/working age population

u^* = "natural rate" of u

w = wage rate

w^* = exogenously determined w

z = exogenous variable

ε = stochastic error

In a world H_0 of flexible wages and a natural rate of unemployment

$$e = f(w) + \varepsilon_e \tag{4A-1}$$

$$\ell = g(z,e) + \varepsilon_\ell \tag{4A-2}$$

$$u = u^* + \varepsilon_u \tag{4A-3}$$

$$\ell \equiv e + u \tag{4A-4}$$

H_0 could be designated as "classical".

In a world H_1 of <u>rigid wages</u> and <u>unemployment as a residual</u>

(4A-5) $e = f(w) + \varepsilon_e$

(4A-6) $\ell = g(z,e) + \varepsilon_\ell$

(4A-7) $u \equiv \ell - e$

(4A-8) $w = w^* + \varepsilon_w$

H_1 could be designated as "Keynesian".

Now, returning to the "classical" world H_0 and substituting (4A-3) into (4A-4), we obtain

(4A-1) $e = f(w) + \varepsilon_e$

(4A-2) $\ell = g(z,e) + \varepsilon_\ell$

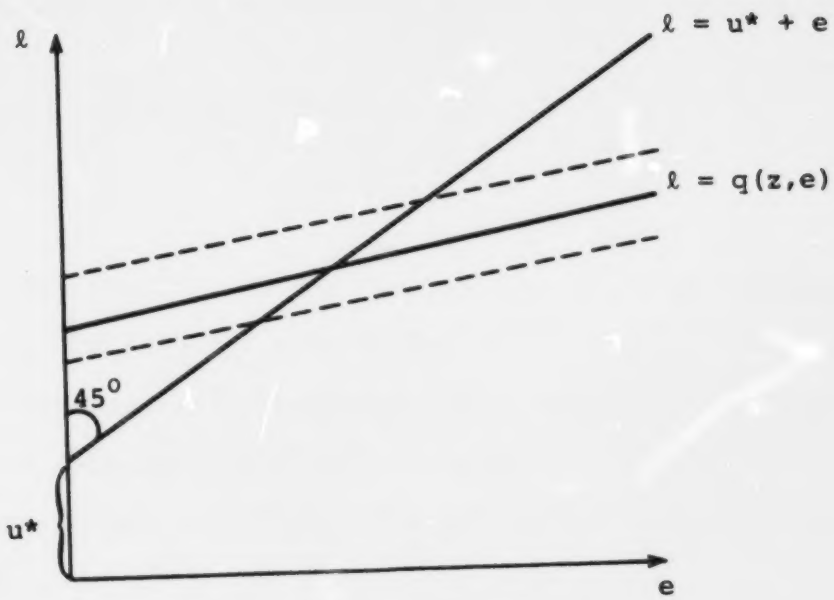
(4A-3) $\ell = u^* + e + \varepsilon_u$

Equation (4A-2) is not identified. This can be illustrated by Chart (4A-1)

Assume, we estimate $\ell = g(z,e)$ directly. With z varying, the estimating equation will pick up the slope of $\ell = u^* + e$, thus overstating the coefficient of e.

In the "Keynesian" world H_1 we can eliminate the identity (4A-7) by eliminating u, leaving

Chart 4A-1



(4A-5) $e = f(w) + \varepsilon_e$

(4A-6) $\ell = g(z,e) + \varepsilon_\ell$

(4A-8) $w = w^* + \varepsilon_w$

Now (4A-6) is identified.

Consider now in more detail what happens if the H_0 world applies, if linearity may be assumed and if there does exist a discouraged worker effect. Then, in this H_0 world, we shall have

(4A-9) $u = u^* + \varepsilon_u$

(4A-10) $\ell = \bar{\alpha} + \bar{\gamma}z + \bar{\beta}e + \bar{\varepsilon}_\ell$

(4A-11) $\ell \equiv e + u$

Substituting (4A-9) into (4A-11)

(4A-12) $\ell \equiv e + u^* + \varepsilon_u$

Taking a weighted combination of (4A-10) and (4A-12)

(4A-13) $\theta_1\ell + \theta_2\ell = \theta_1\bar{\alpha} + \theta_1\bar{\gamma}z + \theta_1\bar{\beta}e + \theta_1\bar{\varepsilon}\ell + \theta_2 e +$
$\theta_2 e + \theta_2 u^* + \theta_2\varepsilon_u$

$$(4A\text{-}14) \qquad \therefore \ell = \frac{\theta_1\bar{\alpha} + \theta_2 u^*}{\theta_1 + \theta_2} + \frac{\theta_1\bar{\beta} + \theta_2}{\theta_1 + \theta_2} e + \frac{\theta_1}{\theta_1 + \theta_2} z + \frac{\theta_1\varepsilon_e + \theta_2\varepsilon_u}{\theta_1 + \theta_2}$$

Now suppose we mistakenly think that the H1 world applies, also with a discouraged worker effect. In this case we have, again assuming linearity as convenient,

$$(4A\text{-}15) \qquad \ell = \alpha + \beta e + \gamma z + \varepsilon_\ell$$

$$(4A\text{-}16) \qquad u \equiv \ell - e$$

Now we have a problem. It arises because we cannot distinguish between (4A-14) and (4A-15), and we cannot say <u>a priori</u> whether the world is Keynesian or classical. If it happens to be classical (H_0), then even with no discouraged worker effect at all, the regression of ℓ on e will fit well, but will be meaningless.

<u>However</u>:

in the H_0 world, substituting (4A-11) into (4A-10) and solving for e gives

$$(4A\text{-}17) \qquad e = \bar{\alpha} + \bar{\gamma} z + \bar{\beta} e - u + \bar{\varepsilon}_\ell$$

and solving for e

$$(4A\text{-}18)\quad e = \frac{\bar{\alpha}}{1-\bar{\beta}} + \frac{\bar{\gamma}}{1-\bar{\beta}} z - \frac{1}{1-\bar{\beta}} u + \frac{\varepsilon_e}{1-\bar{\beta}}$$

in the H_1 world, substituting (4A-16) into (4A-15) gives

$$(4A\text{-}19)\quad e + u = \alpha + \beta e + \gamma z + \varepsilon_\ell$$

and solving for e

$$(4A\text{-}20)\quad e = \frac{\alpha}{1-\beta} + \frac{\gamma}{1-\beta} z - \frac{1}{1-\beta} u + \frac{\varepsilon_\ell}{1-\beta}$$

Comparing (4A-18) with (4A-20) we find: regress e on z and u. In either world with no discouraged worker effect the coefficient of u will be nonsignificantly different from -1.0. If the coefficient of u is significantly greater in absolute value than -1.0, we are in a world with discouraged worker effect.

The estimated coefficient of u in the regression of e on u and z will give the correct estimate of β in equation (4A-15).

Appendix 4-B

Price of Durables and Labour Force Participation in a Very Simple Case

The purpose of this Appendix is to provide a formal exposition of the effect of the ratio of wages to household equipment prices on the participation of women in the labour force.

Consider one person, free to allocate hours and services of durables to household work (L hours, services D of durables). Output of household work (H) is then given by

$$(4B\text{-}1) \quad H = f(D, L)$$

If Y denotes market income net of the purchase of the services of durables this is given as the difference between returns from market work [(8-L) W, where W is the wage rate, and assuming a total of 8 workable hours], and expenditure on services of durables, Dp (if prices of the services of durables is p). So

$$(4B\text{-}2) \quad Y = (8-L)\,W - Dp$$

Total utility, to be maximized, depends on both Y and H, i.e.,

(4B-3) $U = U(Y, H)$

Let (4B-1) be a Cobb Douglas production function with constant returns to scale, so that

(4B-4) $H = D^{\alpha} L^{1-\alpha}$

For any <u>given</u> Y one should always choose D and L to obtain maximum possible H. This is an efficiency condition. It implies we must maximize H in (4B-4), by choice of D and L, subject to the restriction imposed by (4B-2).

Denoting the Lagrangian by $\mathcal{L}$ we have

$$\mathcal{L} = D^{\alpha} L^{1-\alpha} + \gamma \{Y - 8W + LW + Dp\}$$

Maximizing, by choice of D, L <u>and</u> γ, we obtain:

(4B-5) $$\frac{\partial \mathcal{L}}{\partial D} = \alpha D^{\alpha-1} L^{1-\alpha} + \gamma p = 0$$

(4B-6) $$\frac{\partial \mathcal{L}}{\partial L} = (1-\alpha) D^{\alpha} L^{-\alpha} + \gamma W = 0$$

(4B-7) $$\frac{\partial \mathcal{L}}{\partial \gamma} = Y - 8W + LW + Dp = 0$$

Solving (4B-5), (4B-6) and (4B-4) for D and L [first eliminating γ from (4B-5) and (4B-6)] we obtain

$$(4B\text{-}8)\quad D = \frac{\alpha}{1-\alpha}\,\frac{W^{1-\alpha}}{p}\,H$$

$$(4B\text{-}9)\quad L = \frac{1-\alpha}{\alpha}\,\frac{p^{\alpha}}{W}\,H$$

Using these last two equations in (4B-7) we also obtain

$$(4B\text{-}10)\quad Y = 8W - HW^{1-\alpha}\,p^{\alpha}\left[\frac{1-\alpha}{\alpha}^{\alpha} + \frac{\alpha}{1-\alpha}^{1-\alpha}\right]$$

Or, denoting the square bracketed term by B

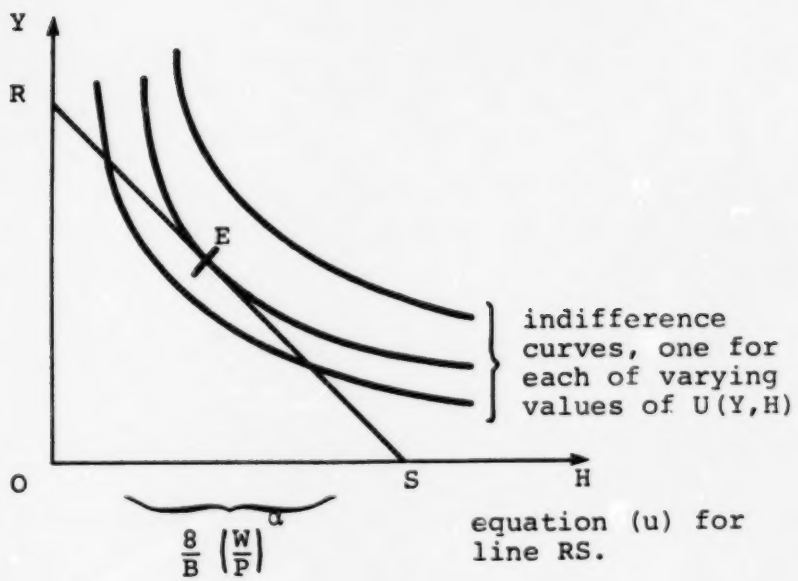
$$(4B\text{-}11)\quad Y = 8W - HW^{1-\alpha}\,p^{\alpha}\,B$$

Consider now the maximizing of utility as given by (4B-3), subject to the constraint (4B-11), by choice of Y and H. This can be done graphically, as shown overleaf, in Chart 4B-1.

The maximum is shown at E.

* * *

Chart 4B-1


Y
R
E
indifference curves, one for each of varying values of U(Y,H)
O
S
H
α
$\frac{s}{B}\left(\frac{W}{P}\right)$
equation (u) for line RS.

Consider now the following problem: what happens to the equilibrium values of Y and H if the price of durables declines?

A decline in p will increase the distance OS, but leave the distance OR unchanged. A new equilibrium is shown in Chart 4B-2, on the assumption that Y is a sufficiently superior good for the income effect on consumption of it to offset the fact that it is now relatively more expensive. Thus, at E', both Y and H have risen.

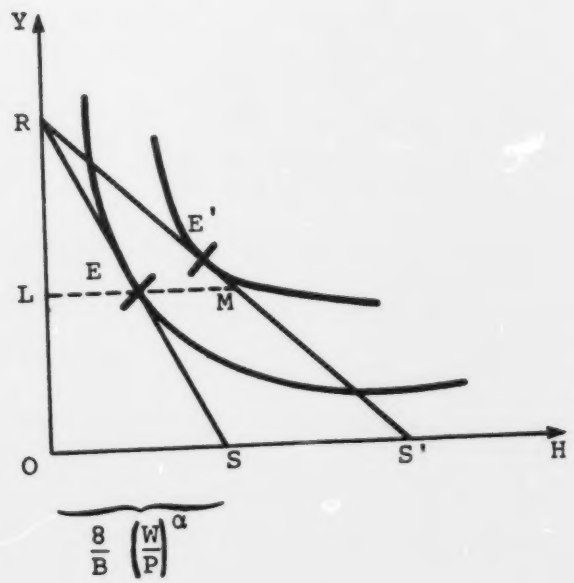
What does this imply for household work, i.e., for the value of L?

To answer this, notice first that in Chart (4B-2) the percentage horizontal shift of the line RS, for any given percentage drop in the price of durables p, is known. Suppose, for example, that p has dropped 10 per cent. Thus SS' will be 10α per cent of OS, so that the horizontal shift of RS is 10α per cent.

In particular, ML is 10α per cent larger than EL. But, because E' is to the left of M, this implies that the increase in consumption of H is <u>less than 10α per cent</u>.

Now consider equation (4B-9). According to equation (4B-9) the percentage change in L when p drops 10 per cent will be the sum of two items: -10α per cent, and the percentage rise in H.

Chart 4B-2



But we just argued that the percentage rise in H was less than 10α per cent. Consequently the net percentage change in L is negative. Thus, household work goes down. Thus, outside work goes up.

We conclude that in this simple model, with certain assumptions, outside work goes up if the price of durables needed in household work goes down.

Chapter 5

DESCRIPTION AND DISCUSSION OF THE EMPIRICAL ESTIMATES

In this chapter we apply the theoretical approach of the previous chapter to the empirical data and discuss the results. Appendix 5A contains a glossary of the mnemonics.

1. Output

The real output of the Mining industry is accepted as exogenous.

The equation of Other Primary Industries follows equation (4-5). The predominant part of this industry consists of Agriculture, the output of which is strongly influenced by weather conditions. Wheat yield per acre sown in Alberta (WY/AA) seemed a useful indicator of weather conditions; however it is necessary to allow for improving agricultural technology, which imparts a rising trend to the yield. Our weather-conditions proxy variable is defined as $(WY/AA)_t / [\sum_{i=0}^{9} (WY/AA)_{t-i}]$, or the current yield over the average of the most recent ten years. The resulting estimate is

Name: Real Output, Other Primary Industries
Mnemonic: XOPA Period: 1962-79
Method: OLS

$$\ln(XOPA/LFA_{-1}) = +0.0247705$$

$$\underset{(0.21)}{+0.151225}\ \ln(PXOPA/WRTA\$)_{-1}$$

$$\underset{(3.67)}{+0.552514}\ \ln(WY/AA)/\left(\frac{\sum_{i=0}^{9}(WY/AA_{t-i})}{10}\right)$$

$$\underset{(3.25)}{+0.501544}\ \ln(XOPA)_{-1}/LFA_{-2})$$

$\bar{R}^2 = 0.728$ S.E.E.= 0.728 D-W= 1.998

Elasticity of Output with respect to price/wage ratio	Short-term	Long-term
	+0.15	+0.30

The numbers in paratheses are t-values.

Construction

This estimate follows the equation (4-9) with several important additions:

a) we have added a dummy variable for the construction of the oil sands plants;

b) we assumed that the Alberta government follows a counter-cyclical policy in the construction of roads, hospitals, schools, government buildings, etc. - i.e. during periods of boom government construction is postponed, while in periods of rising unemployment government accelerates construction activity. However, there is a recognitional, decisional and operational lag between the rise of unemployment and the subsequent rise in

government-induced construction activity; therefore we entered unemployment (UA) with a year's lag into our specification.

c) in our estimates we found that specification (4-9) consistently and substantially over-estimated the amount of construction activity in 1974. This is not surprising when we recall that (4-9) uses the change in current dollar provincial product. In 1974 there was considerable doubt whether the new, high oil price would prove lasting. Indeed, inspection of Alberta's natural resource revenues indicates, that only in 1975 did the oil companies raise their bids for drilling rights by a significant amount (Alberta Statistics Review, 1979 Annual). If the business community was not convinced in 1974 that the oil price increase was lasting, it is not surprising that it did not react to the increase with more construction activity. We decided to dummy out the year 1974, with the following result:

Name: Real Output, Construction — Period: 1965-79
Mnemonic: XCA — Method: OLS

$$XCA - 0.014*KlA_{-1} = \underset{(7.52)}{204.980} \underset{(5.04)}{-170.881}\ D74 \underset{(2.24)}{+2.44738}\ UA_{-1} \underset{(8.22)}{+7.13046}\ DTSPA + \text{sum } (i=0,3)\ b(i)\left(\frac{XNCA_i * PXNCA_i}{PXCA_i} - \frac{XNCA_{i-1} * PXNCA_{i-1}}{PXCA_{i-1}}\right)$$

i	b(i)	t(i)
0	+0.196102	(8.89)
1	+0.188514	(14.92)
2	+0.153301	(7.16)
3	+0.090462	(5.05)
sum	0.628380	(14.92)
	(2,4, FAR)	

$\overline{R}^2 = 0.987$ S.E.E. = 30.685 D-W = 2.349

Substituting the value of 100 for DTSPA into the above equation we find that the Syncrude plant construction increases XCA by approximately $(71) 713 million. Applying to this the deflator of XCA at mid-construction period, we find that according to our equation the Syncrude plant construction amounted to about $1.3 billion in current dollars value added in the construction industry. According to Syncrude Ltd. [The Syncrude Story, n.d. p. 11] the actual cost of the project, exclusive of the utility plant was $2.26 billion.

Manufacturing

This equation was, as we shall see, dogged by a great deal of collinearity between the right-hand side variables. When attempting to fit equation (4-11) the ratio of manufacturing prices/resource industry prices had consistently the wrong (negative) sign. The lagged dependent variable was not significant. We decided to omit the price ratio and arrived at the following preferred version:

Name: Real Output, Manufacturing
Mnemonic: XMFA

Period: 1962-79
Method: OLS

$$\ln(XMFA/LFA_{-1}) = -2.35703 \quad (11.01)$$

$$-0.0533758 \quad (1.71) \quad \ln \; 1./[(\sum_{t=-1}^{-\infty} XMA) * LFA_{-1}]$$

$$+0.849561 \quad (3.05) \quad \ln(XA/LFA_{-1})$$

$$+0.281721 \quad (2.44) \quad \ln(PXNMFTA/WRTA\$)$$

$\overline{R}^2 = 0.977$ S.E.E.= 0.023048 D-W= 2.225

Elasticity of Output

with respect to real provincial product	+0.85
with respect to non-manufactures prices/wage ratio	+0.28

Note that even though the t-values are on the low side, they jointly explain 98 per cent of the variation of the dependent variable. This indicates the high degree of correlation among them.

Services

This follows equation (4-12) in a straightforward manner, with one addition: just as in the case of the construction industry, here too we assumed that government reacts (with a year's lag) to higher unemployment with more employment creation in the non-commercial service sector.

Name: Real Output, Services
Mnemonic: XSA

Period: 1964-79
Method: OLS

$$\ln(XSA/LFA\text{-}1) = -0.782059 \underset{(9.24)}{} + 1.06643\ URATEA_{-1} \underset{(2.58)}{} + \sum_{i=0,3} b(i)\ \ln(XA_{-1}/LFA_{-i-1}) + \sum_{i=0,3} c(i)\ \ln(PXNSTA_{-1}/WRTA\$_{-i})$$

i	b(i)	t(i)	c(i)	t(i)
0	+0.689008	(6.62)	-0.0139208	(0.51)
1	+0.395012	(18.75)	+0.0930620	(4.66)
2	+0.182179	(4.55)	+0.131043	(4.07)
3	+0.050508	(1.21)	+0.100022	(3.81)
sum	+1.31671 (2,4, FAR)	(18.75)	+0.310207 (2,4 FAR)	(4.65)

$\overline{R}^2 = 0.996$ S.E.E.= 0.00762 D-W= 2.396

Elasticity of Output	Short-term	Long-term
with respect to real provincial output	+0.69	+1.32
with respect to non-services price/wage rate	-0.01	+0.31

The long-term elasticity with respect to provincial product is somewhat on the high-side. However the wage rate tends to grow faster than non-service prices and in the long run this presents Services output from growing much faster than total provincial output.

Real Capital Stock in Buildings

Following equation (4-14) we obtain

Name: Capital Stock, Buildings Period: 1961-79
Mnemonic: K1A Method: OLS

$$K1A - K1A_{-1} = \underset{(26.36)}{+2.25373}\ XCA \underset{(9.02)}{-0.0339178}\ K1A_{-1}$$

$\bar{R}^2 = 0.994$ S.E.E.= 45.154 D-W= 2.082

This equation implies that the stock of buildings depreciates at a rate of 3.4 per cent per year. This figure does not appear unreasonable when we recall that the average service-life of industrial buildings is assumed to range between 20 and 50 years [Statistics Canada, 1981, Catalogue No. 13-211 pp. XI-XIII] and that of residential buildings 80 years.

2. Industry Output Prices

The price of mining output (PXMA) is exogenously determined by international prices, taxes and government regulation.

The price of other primary industries (PXOPA) is determined by the price prevailing in the rest of Canada (PXOPR).

Name: Price, Other Primary Industries
Mnemonic: PXOPA

Period: 1962-79
Method: OLS, Hildreth-Lu

$$\ln(PXOPA) = \underset{(1.92)}{+0.0710688} \underset{(7.46)}{+1.55047}\ \ln(PXOPR) \underset{(2.45)}{-0.544975}\ \ln(PXOPR)_{-1}$$

$\bar{R}^2 = 0.967$ S.E.E.= 0.0784 D-W= 1.558 RHO= +0.420

Elasticity of Price with respect to price in ROC	Short-term	Long-term
	+1.55	+1.01

It is somewhat puzzling to find that the price of Alberta's agricultural output is in the short-run substantially more volatile than that of the rest of Canada as reflected by the short-term elasticity. However, the long term elasticity is practically unity, which is a very plausible result.

In estimating the price of the Construction industry we attempted to follow equation (4.18). We added, however, two further dummy variables. The first introduces a dummy variable (D72+) which has the value of zero in the period up to 1971 and unity thereafter. The introduction of this dummy is due to the fact that starting with 1972 the method of compiling the series has been changed by the organization which provides the price data used in this paper (the Conference Board) prior to 1972 the construction industry implicit price deflator for Alberta and Rest of Canada are identical, but they diverge after 1971 [Conference Board, 1980, p. 25].

The second dummy serves to dummy out the year 1978 (D78). According to our database the construction industry price deflator remained unchanged between 1977 and 1978. This seems extremely improbable. Indeed data revisions which became available after we have completed our estimation indicate that the 1978 price was about eight per cent higher than our data-base indicated.

Name: Price, Construction Industry Period: 1961-79
Mnemonic: PXCA Method: OLS

$$\ln(PXCA) = \underset{(34.46)}{-1.63528} \underset{(27.20)}{+0.846257}\ \ln(WRTA\$) \underset{(3.16)}{+2.15922}\ \ln(DTSPA/LFA_{-1}) \underset{(2.20)}{-0.0719069}\ D78 \underset{(3.60)}{+0.0989219}\ D72+$$

$\bar{R}^2 = 0.997$ S.E.E. = 0.029362 D-W = 1.841

The Price Equation of Manufacturing Output assumes that the bulk of manufactured goods is traded or is at least potentially tradeable. In consequence the price is determined in the Rest of Canada, and any difference between the Alberta and Rest of Canada price is due to the differences in the composition of industrial output.

Name: Price, Manufacturing Industries
Mnemonic: PXMFA
Period: 1962-79
Method: OLS

$$\ln(PXMFA) = -0.0118401 \underset{(5.89)}{} + \underset{(28.43)}{+1.15748}\ \ln(PXMFR) - \underset{(2.03)}{0.0946872}\ \ln(PXMFR)_{-1}$$

$\bar{R}^2 = 1.00$ S.E.E. = 0.00586 D-W = 2.111

This equation suggests that the Alberta manufacturing output price is slightly more volatile in the short run than that of the Rest of Canada, but in the longer run the elasticity of Alberta's price with respect to that of R.O.C. is practically unity.

The specification of the price of the Service Industries follows equation (4-19). However, we found that the income variable (XA/LFA_{-1}) yielded a negative coefficient whenever the wage rate variable was also used. Our preferred estimate is:

Name: Price, Service Industries
Mnemonic: PXSA
Period: 1964-79
Method: OLS

$$\ln(PXSA) = -0.986158 \underset{(17.02)}{} + \sum_{i=0,3} b(i)\ \ln(WRTA_{-i}) + \sum_{i=0,3} c(i)\ \ln(PXNSTA_{-i})$$

i	b(i)	t(i)	c(i)	t(i)
0	+0.294828	(4.10)	+0.398751	(8.52)
1	+0.164196	(15.40)	+0.0978864	(7.34)
2	+0.0715138	(1.78)	-0.0688604	(2.56)
3	+0.0167820	(0.43)	-0.101489	(4.08)
sum	+0.547319	(15.40)	+0.326288	(7.34)
	(2,4,FAR)		(2,4,FAR)	

$\bar{R}^2 = 0.999$ S.E.E. = 0.0137 D-W = 1.867

3. Labour Demand

As mentioned in Chapter 4, the labour demand, represented by employment, is estimated as inverted C.E.S. output functions under profit maximization. The results are as follows:

Mining

The time trend was not significant in this equation, and was therefore omitted.

Name: Employment, Mining — Period: 1964-79
Mnemonic: EMA — Method: OLS

$$\ln(EMA) = -1.12669 \underset{(2.58)}{} + 0.957845 \ln(XMA) \underset{(13.78)}{} + \sum_{i=0}^{3} b(i) \ln(WRMA\$(-i)/PXMA(-i))$$

i	b(i)	t(i)
0	-0.122093	(0.98)
1	-0.309245	(9.27)
2	-0.351279	(3.78)
3	-0.248198	(2.95)
sum	-1.03081	(9.272)
	(2,4, FAR)	

$\overline{R}^2 = 0.972$ S.E.E. = 0.0678 D-W = 1.943

Elasticity of Employment	Short-term	Long-term
with respect to real output	+0.96	+0.96
with respect to wage/price ratio	-0.12	-1.03

Other Primary Industries

In this equation output (XOPA) and the time trend proved non-significant.

It should be emphasized that the wage/price ratio entering the employment equation (4-22) applies to the expected wage/price ratio. Our knowledge of expectation formation is very imperfect, but we assumed it to be permissible to represent expectations by distributed lags. In order to increase the flexibility of the equation we entered the price term (PXOPA) and the wage rate (WROPA) as separate variables. This procedure is valid, provided that the sum of the (negative) coefficients of the wage term does not differ significantly from the sum of the (positive) coefficients of the price term. In order to reduce their collinearity (they correlate at +0.89) we deflated both by the Alberta Consumer Price Index.

Name: Employment, Other Primary Industries Period: 1964-79
Mnemonic: EOPA Method: OLS

$$\ln(EOPA) = +4.91256 \quad (133.584)$$
$$-0.352927 \ln(WROPA\$/CPIA) \quad (9.59)$$
$$+\sum_{i=0,3} b(i) \ln(PXOPA/CPIA)$$

i	b(i)	t(i)
0	+0.118944	(2.91)
1	+0.0989292	(3.87)
2	+0.0724337	(2.49)
3	+0.0394574	(1.73)
sum	+0.329764	(3.87)
	(2,4, FAR)	

$\overline{R}^2 = 0.857$ S.E.E. = 0.0383 D-W = 2.710

Elasticities of Employment	Short-term	Long-term
with respect to real price	+0.12	+0.33
with respect to real wage rate	-0.35	-0.35

The fit of this equation is reasonable, but it is the poorest among all the employment equations. However, this is not surprising. Weather conditions may influence output, irrespective of the size of labour input. The contribution of unpaid family members is an important part of the labour input, but it is difficullt to measure. The owner-operator frequently exerts more effort in running his farm, than strict profit vs. effort calculations would justify. Finally, the price of the output is very volatile and may become known only after the harvest.

Construction

Output seems to be by far the strongest determinant of employment. The wage/price ratio displays the correct sign, so we decided to retain it even though it is not significant.

Name: Employment, Construction — Period: 1962-79
Mnemonic: ECA — Method: OLS

$$\ln(ECA) = -2.30467 \underset{(8.47)}{} + 0.760653 \ln(XCA) \underset{(5.14)}{} + 0.221058 \ln(XCA(-1)) \underset{(1.36)}{} - 0.122155 \ln(WRCA\$/PXCA) \underset{(1.28)}{}$$

$\bar{R}^2 = 0.992$ S.E.E.= 0.0328 D-W= 2.221

Elasticity of Employment	Short-term	Long-term
with respect to output	+0.76	+0.98
with respect to wage-price ratio	-0.12	-0.12

Manufacturing

In this equation the coefficient of output was consistently non-significant when the time-trend was included in the specification. It turned highly significant when the time-trend was suppressed. In our preferred equation we chose to retain the output variable and omit the time trend.

Name: Employment, Manufacturing, Alberta
Mnemonic: EMFA
Period: 1961-79
Method: OLS

$$\ln(EMFA) = \underset{(1.12)}{-0.210507} + \underset{(4.85)}{+0.538569}\ \ln(XMFA) \underset{(3.86)}{-0.455565}\ \ln(WRMFA\$/PXMFA) + \underset{(2.68)}{+0.414822}\ \ln(EMFA(-1))$$

$\bar{R}^2 = 0.984$ S.E.E.= 0.0272 D-W= 2.056

Elasticity of Employment	Short-term	Long-term
with respect to real output	+0.54	+0.92
with respect to wage/price ratio	-0.46	-0.78

Services

Here the time trend proved positive and non-significant, if used together with the lagged dependent term. In our final choice the time trend is suppressed.

Name: Employment, Services, Alberta Period: 1961-79
Mnemonic: ESA Method: OLS

$$\ln(ESA) = \underset{(0.03)}{-0.00227} \underset{(3.90)}{+0.4743}\ \ln(XSA) \underset{(2.88)}{-0.1951}\ \ln(WRSA\$/PXSA) \underset{(2.47)}{+0.4055}\ \ln(ESA(-1))$$

$\bar{R}^2 = 0.999$ S.E.E.= 0.00958 D-W= 2.114

Elasticity of Employment	Short-term	Long-term
with respect to real output	+0.47	+0.80
with respect to wage/price ratio	-0.20	-0.33

Summarizing the employment equations, we find that -- with a single exception -- all equations show a positive output elasticity of employment, and this elasticity is below unity. The one exception which did not show a significant effect of output on employment, is Other Primary Industries, i.e., in Alberta's case Agriculture. Employment in this industry consists of a very large percentage of owner-operators; therefore employment policy in this case would differ substantially from other industries.

Employment is in all cases negatively related to wages and positively related to output prices. Mining employment is particularly sensitive to fluctuations of this profitability proxy. The Service industry is least sensitive to it, which is not surprising when we recall that a large part of the service industry is in the non-commercial sector (civil service, schools, hospitals, etc.).

Labour Supply

The Alberta labour supply is represented in this study by that part of the population aged 15 years and over (POP15+A), which is employed or actively searching for work. We define the labour force participation rate of Alberta (PARTRA) as

(5-1) PARTRA $\equiv$ LFA/POP15+A •

where LFA is the labour force of Alberta.

Appendix 4-A has demonstrated that it is not appropriate to introduce the ratio of employed persons/population aged 15 and over (ETA/POP15+A) directly into the participation rate equation. Instead, it is necessary to regress ETA/POP15+A on the ratio of unemployed/population aged 15 and over (UA/POP15+A) and whichever additional variables we intend to introduce into the participation rate equation.

As mentioned in Chapter 4, we have attempted to explain the rising trend of the participation rate by three variables: the ratio of births to population, the ratio of wage to the price of household durables (WRTA$/PFCDH20) and a time trend.

We used WRTA$/PFCDH20 in the following way: PFCDH20 is a price index on 1971=1.0 base, therefore we normalized WRTA$ similarly by dividing it by its 1971 value of 6.609. In order to restrain the

effect of the normalized WRTA$/PFCDH20 variable to the range between zero and unity, (the dependent variable has to be within this range) we used the hyperbolic tangent transformation

(5-2) TANHIW/PA = (e**[WRTA$/(PFCDH20*6.609)] -1.0) /
(e**[WRTA$/(PFCDH20*6.609)] +1.0)

which has the desired value of zero, when the ratio WRTA$/PFCDH20 is zero, and approaches the value of unity as the wage/price ratio reaches ever higher values and approaches infinity.

Unfortunately the ratio of births to population WBIRTHSRA specified as $[(0.5*Births_t + 0.4*Births_{t-1} + 0.3*Births_{t-2} + 0.2*Births_{t-3} + 0.1*Births_{t-4})/POP15+A_t]$, the domestic appliances/wage rate ratio, and the time trend are all very highly correlated with each other. When we attempted to introduce both the wage price ratio and the births/population ratio into the equation (4A-20), we found that the births/population ratio had the wrong (positive) sign and was non-significant. Using the three proposed variables individually, we obtained the following three results (ETA/POP15+A is the dependent variable).

	1.	2.	3.
C	+0.519623	+0.240661	+0.736823
	(122.0)	(18.51)	(35.80)
UA/POP15+A	-1.59373	-1.26749	-1.09818
	(8.84)	(6.46)	(2.28)
TANHIW/PA	+0.258041		
	(29.62)		
WBIRTHSRA			-3.75639
			(10.05)
TIMEA		+0.00548	
		(26.36)	
$\bar{R}^2$	0.980	0.975	0.848
S.E.E.	0.00425	0.00476	0.01171
D-W	2.082	1.348	0.342

These results clearly show that equation 1 is the best of the three. Both the correlation coefficient and the Durbin-Watson statistic indicate that the wage/appliance price ratio explains the employment/source population ratio better than does the birth-rate. The equation with the time-trend is also inferior to the one with the wage/price ratio. In addition we believe that using a time-trend as a proxy for changing social forces is a dangerous practice in forecasting, because it assumes that the changes of the past will continue monotonically and in a linear fashion in the future. Using the equation utilizing TANHIW/PA we find that the coefficient of UA/POP15+A is -1.59373, indicating a discouraged worker effect. This corresponds to the coefficient $(-\frac{1}{1-\beta})$ in equation (4A-20). Solving for β we obtain +0.37254. This is the correct estimate for β in our desired equation (4A-15). In estimating our equation for the participation rate PARTRA we imposed the coefficient +0.37254 on the variable ETA/POP15+A, with the following result

Name: Labour Force Participation Rate
Mnemonic: PARTRA Period: 1960-79
Method: OLS

PARTRA -0.37254 (ETA/POP15+A) = +0.326175
(161.13)
+0.161542 TANHIW/PA
(35.63)

$\overline{R}^2$ = 0.985 S.E.E.= 0.00257 D-W= 2.041

4. Wage Rate

The overall average wage rate of Alberta (WRTA$) is modelled as a Phillips curve. The percentage change of the wage rate is a function of the reciprocal of the lagged unemployment rate (the proxy indicator of labour surplus), in order to capture the possible non-linear relationship between labour surplus and wage changes. The wage bargain is assumed to be concluded in real terms; however, the two parties to the wage bargain, labour and management are looking at two different price indicators: labour at the consumer price index, management at the product price, here represented by the provincial product deflator (PXA). We have, for simplicity's sake, assumed that the arithmetic average of the CPI inflation and of the PXA inflation (PHPA) will be an acceptable indicator. Also, we introduced a dummy variable to represent the 1976-78 effect of wage controls (DWRC).

Name: Wage Rate, Total
Mnemonic: WRTA$

Period: 1964-79
Method: OLS

$$(WRTA\$ - WRTA\$_{-1})/WRTA\$_{-1} = \underset{(0.11)}{0.00284915}$$
$$\underset{(1.88)}{+0.00142962}\ (1.0/URATEA\text{-}1)$$
$$\underset{(1.98)}{-0.0129637}\ DWRC$$
$$+\sum_{i=0,2} b(i)\ ((PHPA_{-i} - PHPA_{-i-1}/PHPA_{-i-1})$$

i	b(i)	t(i)
0	+0.390348	(2.72)
1	+0.310441	(4.45)
2	+0.180324	(1.80)
sum	+0.88114	(6.72)
	(2,3,FAR)	

$\overline{R}^2 = 0.738$ S.E.E. = 0.0188 D-W = 2.400

The long term effect of one per cent average increase of CPI and PXA on wages is 0.88 per cent, but this does not differ significantly from unity.

Theoretical considerations strongly suggest that the unemployment rate should appear in the wage equation in reciprocal form, as modelled above. However, several important studies (for reference see Santomero A.M. and Seater J.J. [1978] p. 505) found the use of the linear form preferable in empirical work; therefore we have also estimated the wage equation with the rate in linear form.

$$(WRTA\$ - WRTA\$_{-1})/WRTA\$_{-1} = \underset{(4.22)}{0.08335539}$$
$$\underset{(2.01)}{-1.04529} \; URATEA_{-1}$$
$$\underset{(2.06)}{-0.0131756} \; DWRC$$
$$+\text{sum } (i=0,2)\ b(i)\ ((PHPA_{-i} - PHPA_{-i-1})/PHPA_{-i-1})$$

i	b(i)	t(i)
0	+0.419389	(2.87)
1	+0.295459	(4.29)
2	+0.155663	(1.54)
sum	+0.870511	(6.87)
	(2,3,FAR)	

$\bar{R}^2 = 0.748$ S.E.E. = 0.0184 D-W = 2.339

The single-equation fits of the two versions are practically indistinguishable from each other.

We intended to model the wage rate of the individual industries in the following manner: the ratio of industry i wage rate to the overall wage rate is a function of the industry-specific labour surplus and of a partial adjustment process. We intended to proxy the specific labour surplus by the growth-rate of the output of the corresponding industry (Xi/Xi_{-1}). Unfortunately this approach proved completely unsuccessful. We were reduced to regressing the wage ratio on a constant and its own lagged value. The sum of industry-specific wage rates multiplied by the corresponding employment figures have to be equal to the total wage bill of Alberta. We imposed this constraint by using Zellner's seemingly unrelated regression technique. The restriction forces the omission of one equation from the estimation -- the wage rate of this industry is obtained as the

residual. We chose to omit the Services industry. This is the biggest industry in our disaggregation; so it will do relatively least harm if it is the one forced to absorb all the errors of our wages sub-system.

Name: Wage Rate, Mining
Mnemonic: WRMA$

Period: 1962-79
Method: Zellner seemingly unrelated regressions

$$\ln(WRMA\$/WRTA\$) = \underset{(1.55)}{+0.1938272} + \underset{(4.07)}{+0.7136329}\ \ln(WRMA\$/WRTA\$)_{-1}$$

$R^2 = 0.4629$

Name: Wage Rate, Other Primary Industries
Mnemonic: WROPA$

Period: 1962-79
Method: Zellner seemingly unrelated regressions

$$\ln(WROPA\$/WRTA\$) = \underset{(1.56)}{-0.270309} + \underset{(3.56)}{+0.6705313}\ \ln(WROPA\$/WRTA\$)_{-1}$$

$R^2 = 0.3962$

Name: Wage Rate, Construction
Mnemonic: WRCA$

Period: 1962-79
Method: Zellner seemingly unrelated regressions

$$\ln(WRCA\$/WRTA\$) = \underset{(1.64)}{+0.153555} + \underset{(2.76)}{+0.5974973}\ \ln(WRCA\$/WRTA\$)_{-1}$$

$R^2 = 0.3579$

Name: Wage Rate, Manufacturing
Mnemonic: WRMFA$

Period: 1962-79
Method: Zellner seemingly unrelated regressions

$$\ln(WRMFA\$/WRTA\$) = \underset{(2.39)}{+0.0461099} + \underset{(4.35)}{+0.6007476}\ \ln(WRMFA\$/WRTA\$)_{-1}$$

$R^2 = 0.5077$

5. Migration

a) International Migration into Alberta

We have experimented with the numerous income concepts described in equations (4-30) to (4-36). The most successful was the one corresponding to (4-33). The ratio of provincial resource revenues per capita was not significant. On the other hand the ratio of employment growth had the desired sign and was significant.

Name: International Migration to Alberta
Mnemonic: MIGFIA
Period: 1963-79
Method: OLS

$$\ln\left(\frac{(MIGFIA/POP15+A_{-1})}{((MIGTIC-MIGFIA)/POP15+R_{-1})}\right) = \underset{(3.02)}{+0.142175}$$

$$+ \underset{(1.98)}{1.94639}\ \ln\left(\frac{(ETA-EOPA)-(ETA-EOPA)_{-1})/(ETA-EOPA)_{-1}}{(ETR-EOPR)-(ETR-EOPR)_{-1})/(ETR-EOPR)_{-1}}\right)$$

$$+ \text{sum } (0,3)\ b(i)\ \ln\left(\frac{WRTA\$_{-i}(1-URATEA_{-i})/CPIA_{-i})}{WRTR\$_{-i}(1-URATER_{-i})/CPIR_{-i})}\right)$$

i	b(i)	t(i)
0	+3.76947	(7.53)
1	+1.01833	(8.02)
2	-0.526962	(1.70)
3	-0.866405	(3.02)
sum	3.39443	(8.02)

$\bar{R}^2 = 0.945$ S.E.E. = 0.0621 D-W = 1.549

b) International Migration from Alberta

This equation is the counterpart of the preceding one

Name: International Migration from Alberta
Mnemonic: MIGFOA
Period: 1961-79
Method: OLS, Hildreth-Lu

$$\ln\left(\frac{(MIGFOA/POP15+A_{-1})}{((MIGTOC-MIGFOA)/POP15+R_{-1})}\right)$$

$$= \underset{(1.70)}{-0.237506}$$

$$\underset{(1.29)}{-1.74808} \quad \ln\left(\frac{WRTA\$(1-URATEA)/CPIA}{WRTR\$(1-URATER)/CPIR}\right)$$

$$\underset{(1.49)}{-3.68090} \quad \ln\left(\frac{[(ETA-EOPA)-(ETA-EOPA)_{-1}]/(ETA-EOPA)_{-1}}{[(ETR-EOPR)-(ETR-EOPR)_{-1}]/(ETR-EOPR)_{-1}}\right)$$

$R^2 = 0.536$ S.E.E. = 0.191 D-W = 1.641 RHO = +0.532

The right-hand side variables are correlated with each other, therefore their low t-values are deceptive. If the wage ratio variable is used by itself, its t-value is 3.30; and if the employment growth variable is used by itself its t-value is 1.88.

c) Interprovincial Migration into Alberta

During our work on this equation it became increasingly obvious that general business conditions have a strong positive effect on migration both into and out of Alberta. This is in agreement with the findings of Vanderkamp [1969] and of Courchene [1970], who used the unemployment rate as the indicator of business activity. Their explanation for this phenomenon was that generally favourable conditions promote migration to high-income regions;

however a high number of optimistic migrants also results in a higher number of disappointments and therefore a higher number of return migrants to the lower-income region. Since the Vanderkamp and Courchene studies the natural rate of unemployment in Canada has risen. We have therefore chosen the manufacturing capacity utilization rate (MFCAPUTC) as the indicator of economic prosperity.

Any attempt to model migration with disaggregated indicators of provincial resource revenues proved unsuccessful. While this is regrettable, it is not surprising. Our migration data base starts as recently as the 1961-62 demographic year. Also, the big increase in Alberta's resource revenues started as recently as 1974 and the various uses of these revenues (tax reductions, expenditure increases, Heritage fund asset growth) are all highly correlated with each other. Under such circumstances it is not surprising that only the aggregate per capita ratio of provincial resource revenues proved itself useful in explaining migration, besides the wage ratio and the capacity utilization rate.

Name: Interprovincial Migration into Alberta
Mnemonic: MIGPIA
Period: 1961-79
Method: OLS

$$\ln(MIGPIA/POP15+R_{-1}) = -9.42238 \quad (9.80)$$
$$+2.48304 \quad (6.61) \quad \ln(WRTA\$/WRTR\$)$$
$$+0.938225 \quad (4.22) \quad \ln(MFCAPUTC)$$
$$+0.0687485 \quad (2.21) \quad \ln\left(\frac{(GRNRA\$/POP15+A_{-1})}{(GRNRR\$/POP15+R_{-1})}\right)$$

$\bar{R}^2 = 0.904$ S.E.E. = 0.0444 D-W = 2.206

d) Interprovincial Migration from Alberta

The equation corresponding to the preceding is

Name: Interprovincial Migration from Alberta
Mnemonic: MIGPOA
Period: 1961-79
Method: OLS

$$\ln(MIGPOA/POP15+A_{-1}) = -8.82417 \quad (5.98)$$
$$-0.271803 \quad (0.47) \quad \ln(WRTA\$/WRTR\$)$$
$$+1.35463 \quad (3.97) \quad \ln(MFCAPUTC)$$
$$-0.0873836 \quad (1.83) \quad \ln\left(\frac{(GRNRA\$/POP15+A_{-1})}{(GRNRR\$/POP15+R_{-1})}\right)$$

$\bar{R}^2 = 0.578$ S.E.E. = 0.068147 D-W = 1.775

It is interesting to note that the wage-ratio has a very significant (positive) effect on migration into Alberta, but no significant effect on the out-migration. The government natural

resource revenue ratio has an approximately symmetrical effect, and capacity utilization has a pronounced positive effect on movements in both directions -- rather stronger on migration out of Alberta than into the province.

e) Alternative Specifications for Interprovincial Migration

Here we have followed stocks-flows specification recommended by Lianos. We took as our point of departure the specifications of sections 5c and 5d of the present chapter and used (the Almon distributed lags of) the change of the right-hand side variables. We shall designate this specification as the "stock-flow" (s-f) specification.

Recall that according to the "stock-flow" hypothesis net inter-provincial migration should be zero in the long run if the change in the explanatory variables is zero. However, when we estimated the equations for interprovincial in- and out-migration with s-f specification, but with the constant term unrestricted, we obtained a (small) net migration even when the right-hand side variables remained unchanged. In our final estimate we modified the constant terms so as to yield zero net migration and imposed these constant terms on the equations, with the following results:

Name: Interprovincial Migration into Alberta (s-f)
Mnemonic: MIGPIA
Period: 1965-79
Method: OLS

$$\ln(MIGPOA/POP15+R_{-1}) + 5.46266 =$$

$$+\text{sum } (0,3)\ b(i)\ \ln\left(\frac{\frac{WRTA\$_i}{WRTR\$_i}}{\frac{WRTA\$_{(i-1)}}{WRTR\$_{(i-1)}}}\right)$$

$$+\text{sum } (0,3)\ c(i)\ \ln\left(\frac{MFCAPUTC_i}{MFCAPUTC_{i-1}}\right)$$

$$+\text{sum } (0,3)\ d(i)\ \ln\left(\frac{\frac{GRNRA\$_i}{POP15+A_{i-1}}\ \frac{GRNRR\$_i}{POP15+R_{i-1}}}{\frac{GRNRA\$_{i-1}}{POP15+A_{i-2}}\ \frac{GRNRR\$_{i-1}}{POP15+R_{i-2}}}\right)$$

i	b(i)	t(i)	c(i)	t(i)	d(i)	t(i)
0	+4.01532	(2.54)	+1.84286	(3.49)	+0.244524	(2.53)
1	+4.74511	(6.71)	+1.11547	(2.49)	+0.165510	(3.42)
2	+4.31915	(3.82)	+0.565867	(1.03)	+0.984181	(1.44)
3	+2.73745	(2.86)	+0.194043	(0.46)	+0.0432482	(0.75)
sum	+15.8170 (2,4,FAR)	(6.17)	+3.71825 (2,4,FAR)	(2.49)	+0.551700 (2,4,FAR)	(3.42)

$\bar{R}^2 = 0.635$ S.E.E. = 0.079431 D-W = 1.591

Name: Interprovincial Migration from Alberta
Mnemonic: MIGPOA
Period: 1965-79
Method: OLS

$$\ln(MIGPOA/POP15+A_{-1})+2.93886 =$$

$$+\text{sum}\ (0,3)\ b(i)\ \ln\left(\frac{WRTA\$_i/WRTR\$_i}{WRTA\$_{i-1}/WRTR\$_{i-1}}\right)$$

$$+\text{sum}\ (0,3)\ c(i)\ \ln\left(\frac{MFCAPVTC_i}{MFCAPVTC_{i-1}}\right)$$

$$+\text{sum}\ (0,3)\ d(i)\ \ln\left(\frac{\frac{GRNRA\$_i}{POP15+A_{i-1}}\quad\frac{GRNRR\$_i}{POP15+R_{i-1}}}{\frac{GRNRA\$_{i-1}}{POP15+A_{i-2}}\quad\frac{GRNRR\$_{i-1}}{POP15+R_{i-2}}}\right)$$

i	b(i)	t(i)	c(i)	t(i)	d(i)	t(i)
0	+0.791032	(0.72)	+1.38174	(3.77)	-0.162633	(2.42)
1	-1.64447	(3.08)	+0.530769	(1.71)	-0.0944462	(2.81)
2	-2.58814	(3.30)	+0.0168211	(0.04)	-0.0446124	(0.94)
3	-2.03999	(3.07)	-0.160102	(0.55)	-0.0131303	(0.33)
sum	-5.48156	(3.08)	+1.76923	(1.71)	-0.314821	(2.81)
	(2,4,FAR)		(2,4,FAR)		(2,4,FAR)	

$\bar{R}^2 = 0.759$ S.E.E. = 0.055138 D-W = 1.611

It is not possible to determine by inspection whether the "conventional" or the "s-f" specification is superior. We have performed dynamic full period simulations over the 1965-79 period with both specifications. The conventional specification yielded convincingly superior results. In the following chapters we shall discuss only simulations using the conventional specification.

Appendix 5-A

Glossary of Mnemonics

BIRTHSA	Number of Births, Alberta
CPIA	Consumer Price Index, Alberta
CPIC	Consumer Price Index, Canada
CPIGC	Consumer Price Index, Goods, Canada
CPIGSTAIC	= CPIGC * (1+RSTRA)*.93925/(1+RSTRR)
CPIR	Consumer Price Index, Rest of Canada
DTSPA	Oil Sand Plant Construction Dummy, Alberta
DWRC	Wage Control Dummy, Canada
D72+	Dummy Variable, value = 1.0 in 1972 and after, zero before 1972
D74	Dummy Variable, unity in 1974, zero else
D78	Dummy Variable, unity in 1978, zero else
ECA	Employed, Construction Industry, Alberta
EMA	Employed, Mining Industry, Alberta
EMFA	Employed, Manufacturing Industry, Alberta
EOPA	Employed, Other Primary Industries, Alberta
EOPR	Employed, Other Primary Industries, Rest of Canada
ESA	Employed, Service Industry, Alberta
ETA	Employed, Total, Alberta
ETR	Employed, Total, Rest of Canada
GRNRA$	Government Revenues from Natural Resources, Current $, Alberta
GRNRR$	Government Revenues from Natural Resources, Current $, Rest of Canada

KMIGA	Share of population aged 15+, of total migrants, Alberta
KIA	Capital Stock, Buildings, in constant $, Alberta
LFA	Labour Force, Alberta
LFR	Labour Force, Rest of Canada
MFCAPUTC	Capacity Utilization Rate, Manufacturing, Canada
MIGFIA	Gross International Migration into Alberta
MIGFNA	Net International Migration into Alberta
MIGFOA	Gross International Migration from Alberta
MIGPIA	Gross Interprovincial Migration into Alberta
MIGPNA	Net Interprovincial Migration into Alberta
MIGPOA	Gross Interprovincial Migration out of Alberta
MIGTIC	Gross International Migration into Canada
MIGTNA	Net Total Migration into Alberta
MIGTNC	Net Total Migration into Canada
MIGTNR	Net Total Migration into Rest of Canada
MIGTOC	Gross Total Migration out of Canada
PARTRA	Labour Force Participation Rate, Alberta
PFCDH20	Price Index, Household Appliances, Canada
PHPA	$PHPA + PHPA_{-1} + PHPA_{-1} * \left(-.5 * \left(\frac{CPIA - CPIA_{-1}}{CPIA_{-1}} + \frac{PXA - PXA_{-1}}{PXA_{-1}}\right)\right)$

POPNGA	National Population Growth Rate, Alberta
POPNGR	Natural Population Growth Rate, Rest of Canada
POP15+A	Population aged 15 and over, Alberta
POP15+R	Population aged 15 and over, Rest of Canada
PXA	Real Provincial Product Deflator, Alberta
PXCA	Real Provincial Product Deflator, Construction Industry, Alberta
PXCR	Real Provincial Product Deflator, Construction Industry, Rest of Canada
PXMA	Real Provincial Product Deflator, Mining Industry, Alberta
PXMR	Real Provincial Product Deflator, Mining Industry, Rest of Canada
PXMFA	Real Provincial Product Deflator, Manufacturing Industry, Alberta
PXMFR	Real Provincial Product Deflator, Manufacturing Industry, Rest of Canada
PXNCA	$\frac{XA\$ - (XCA * PXCA)}{XA - XCA}$
PXNMFA	(XMA*PXMA + XOPA*PXOPA + XCA*PXCA + XSA*PXSA) / (XMA + XOPA + XCA + XSA + RPPADJA)
PXNMFTA	= 0.6 * PXNMFA + 0.4*CPIGSTAIC
PXNSA	(XMA*PXMA + XOPA*PXOPA + XCA*PXCA + XMFA*PXMFA) / (XMA + XOPA + XCA + XMFA + RPPADJA)
PXNSTA	= 0.53 * PXNSA + 0.47*CPIGSTAIC
PXOPA	Real Provincial Product Deflator Other Primary Industries, Alberta
PXOPR	Real Provincial Product Deflator Other Primary Industries, Rest of Canada

PXR	Real Provincial Product Deflator, Rest of Canada
PXSA	Real Provincial Product Deflator Service Industries, Alberta
PXSR	Real Provincial Product Deflator, Service Industries, Rest of Canada
RPPADJA	Real Provincial Product Adjusting Entry, Alberta
RPPADJR	Real Provincial Product, Adjusting Entry, Rest of Canada
RSTRA	Provincial Retail Sales Tax Rate, Alberta
RSTRR	Provincial Retail Sales Tax Rate, Rest of Canada
SXMA	Cumulated Real Provincial Product, Mining Industry, Alberta
TANHIW/PA	= (e**[WRTA$/(PFCDH20*6.609)] - 1.0) / (e**[WRTA$/(PFCDH20*6.609)] + 1.0)
TIMEA	Time Trend
UA	Unemployed, Alberta
UR	Unemployed, Rest ot Canada
URATEA	Unemployment Rate, Alberta
URATER	Unemployment Rate, Rest of Canada
WBCA$	Labour Income, Construction, Alberta
WBIRTHSRA	= [(0.5 * BIRTHSA + 0.4 * $BIRTHSA_{-1}$ + 0.3 * $BIRTHSA_{-2}$ + 0.2 * $BIRTHSA_{-3}$ + 0.1 * $BIRTHSA_{-4}$) / POP15+A]
WBMA$	Labour Income, Mining, Alberta
WBMFA$	Labour Income, Manufacturing, Alberta
WBOPA$	Labour Income, Other Primary Industries, Alberta
WBSA$	Labour Income, Service Industries, Alberta

WBTA$	Labour Income, Total, Alberta
WBTR$	Labour Income, Total, Rest of Canada
WRCA$	Labour Income per Employed Person, Construction Industry, Alberta
WRMA$	Labour Income per Employed Person, Mining Industry, Alberta
WRMFA$	Labour Income per Employed Person, Manufacturing Industry, Alberta
WROPA$	Labour Income per Employed Person, Other Primary Industries, Alberta
WRSA$	Labour Income per Employed Person, Service Industry, Alberta
WRTA$	Labour Income per Employed Person, Alberta
WRTR$	Labour Income per Employed Person, Rest of Canada
WY/AA	Wheat Yield per Acre, Alberta
XA	Real Provincial Product, Alberta
XA$	Gross Provincial Product, Alberta
XCA	Real Provincial Product, Construction Industry, Alberta
XCR	Real Provincial Product, Construction Industry, Rest of Canada
XMA	Real Provincial Product, Mining Industry, Alberta
XMR	Real Provincial Product, Mining Industry, Rest of Canada
XMFA	Real Provincial Product, Manufacturing, Alberta
XMFR	Real Provincial Product, Manufacturing, Rest of Canada
XNCA	XA-XCA

XOPA	Real Provincial Product Other Primary Industries, Alberta
XOPR	Real Provincial Product, Other Primary Industries, Rest of Canada
XR	Real Provincial Product, Rest of Canada
XSA	Real Provincial Product, Service Industries, Alberta
XSR	Real Provincial Product, Service Industries, Rest of Canada

Chapter 6

SIMULATIONS

A. Projections

In this chapter we report the results of four simulations we have performed with the model. We have attempted to answer the following questions:

If in the 1980-2000 period conventional oil and natural gas output declines in line with the National Energy Board forecast of June 1981 and there are no further oil-sand plants built; will Alberta continue to have a higher real output growth rate than the rest of Canada? Will its unemployment rate remain below the national average? Will the recent high net immigration continue? Does the sensitivity of the Alberta wage increases with respect to the provincial unemployment rate significantly influence the outcome? To what extent would the construction of four more Syncrude-size oil sand plants during the next two decades stimulate Alberta's growth?

1.a) The exogenous variables for the Rest of Canada used in the base case of projections were in general derived from the CANDIDE projection FCST.27.CNTL. For Albert's mining output growth we used: for oil, the National Energy Board's Modified Base Case from Canadian Energy: Supply and Demand 1980-2000, June 1981, p. 147,

Chart 6-1

Real Provincial Product, Alberta

(Billion 1971$)

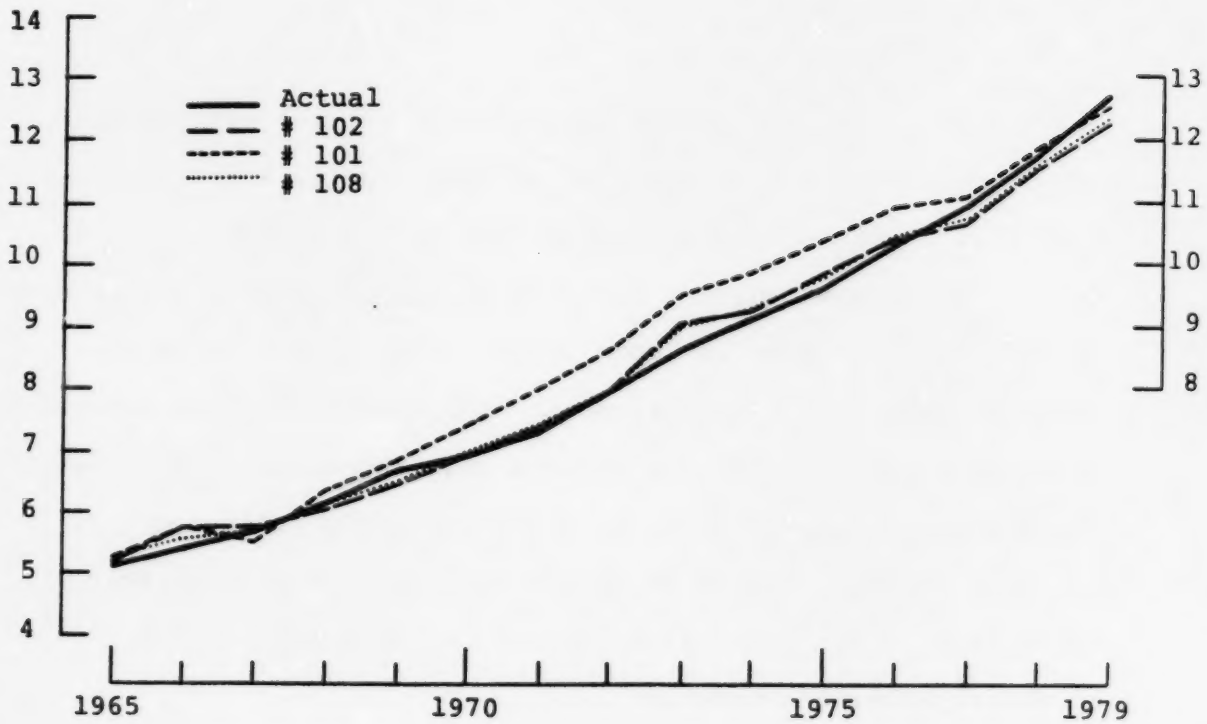


Chart 6-2

Labour Income per Employed Person, Alberta

(Thousand 1971$)

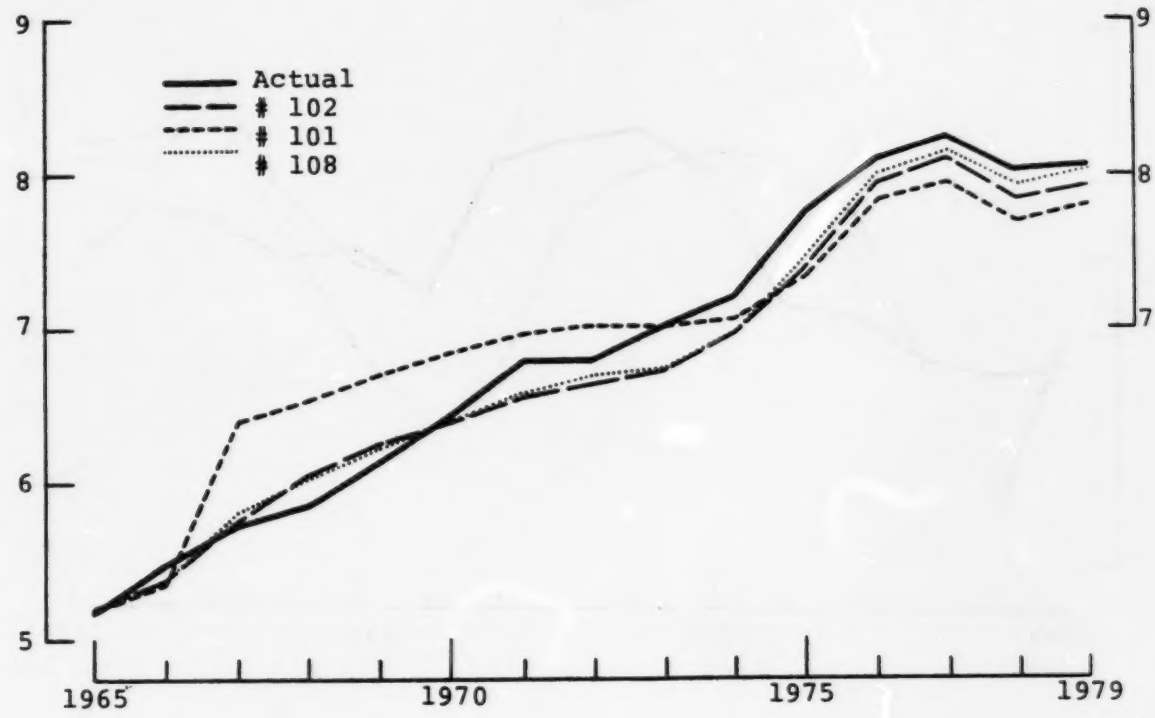


Chart 6-3

Unemployment Rate, Alberta

(per cent)

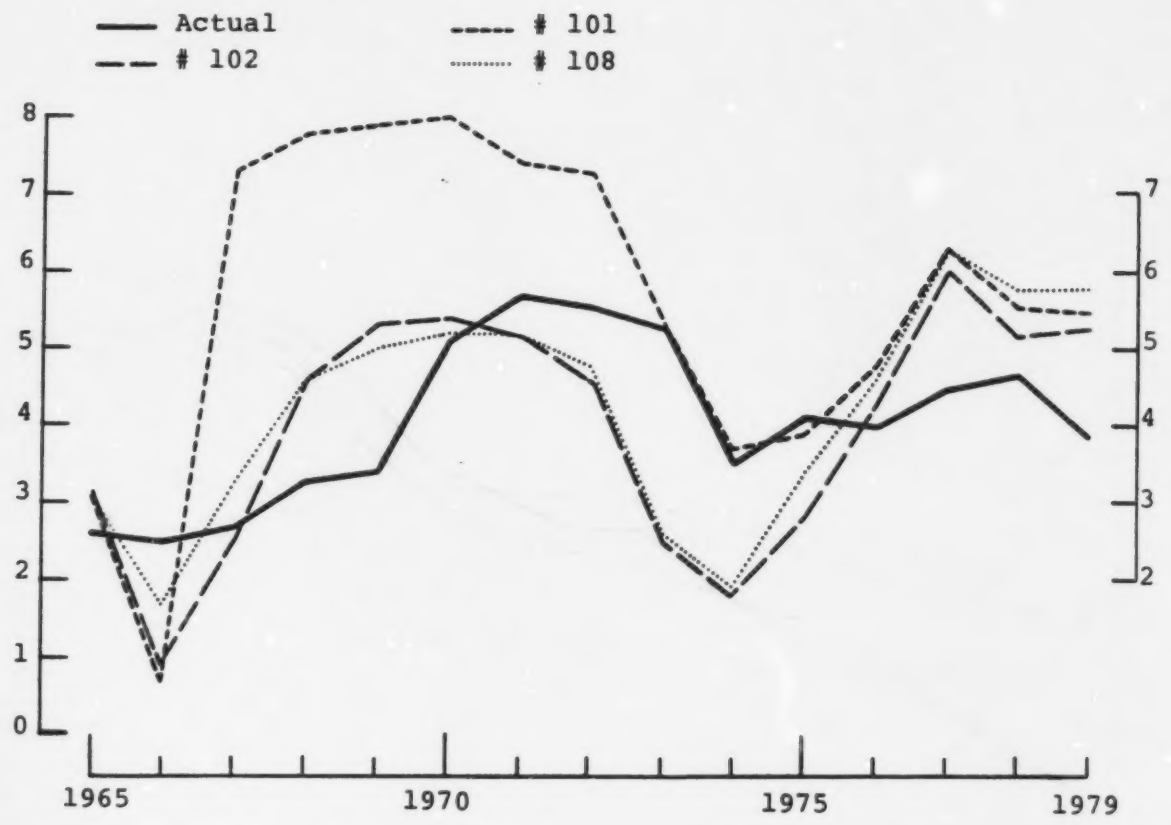


Chart 6-4

Net Migration into Alberta

(Thousand Persons)

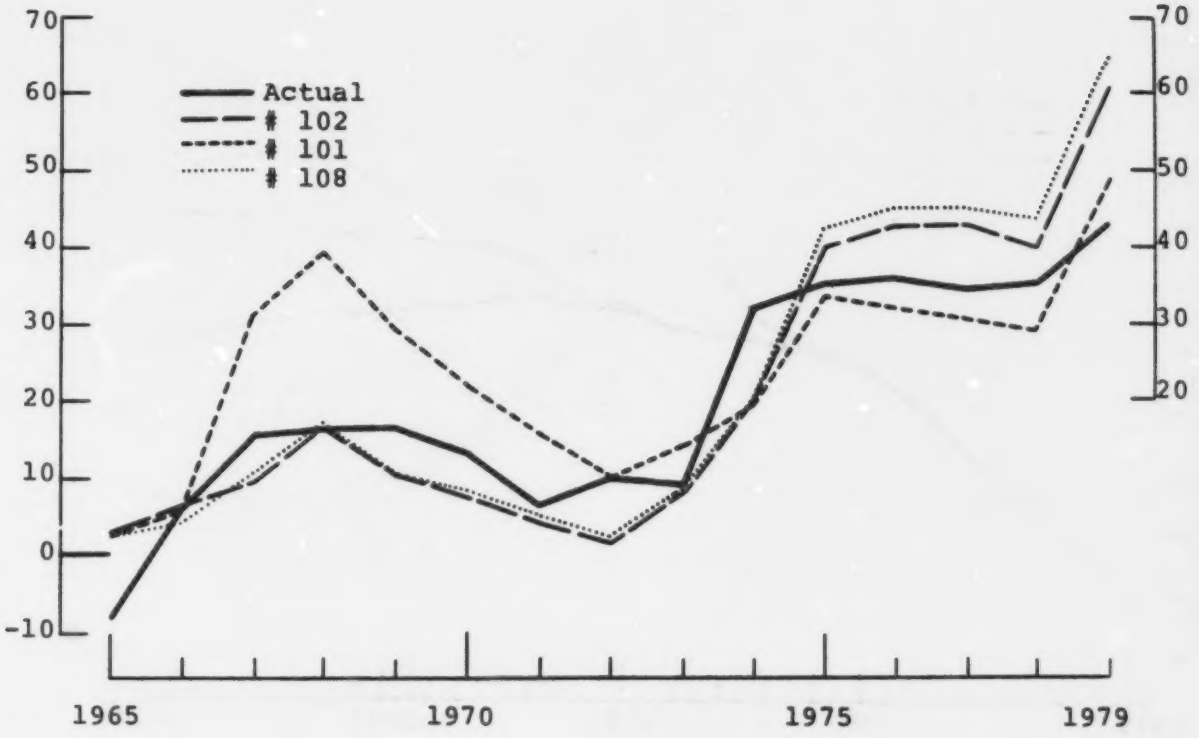


Chart 6-5

Real Provincial Product, Alberta

(Billion 1971$)

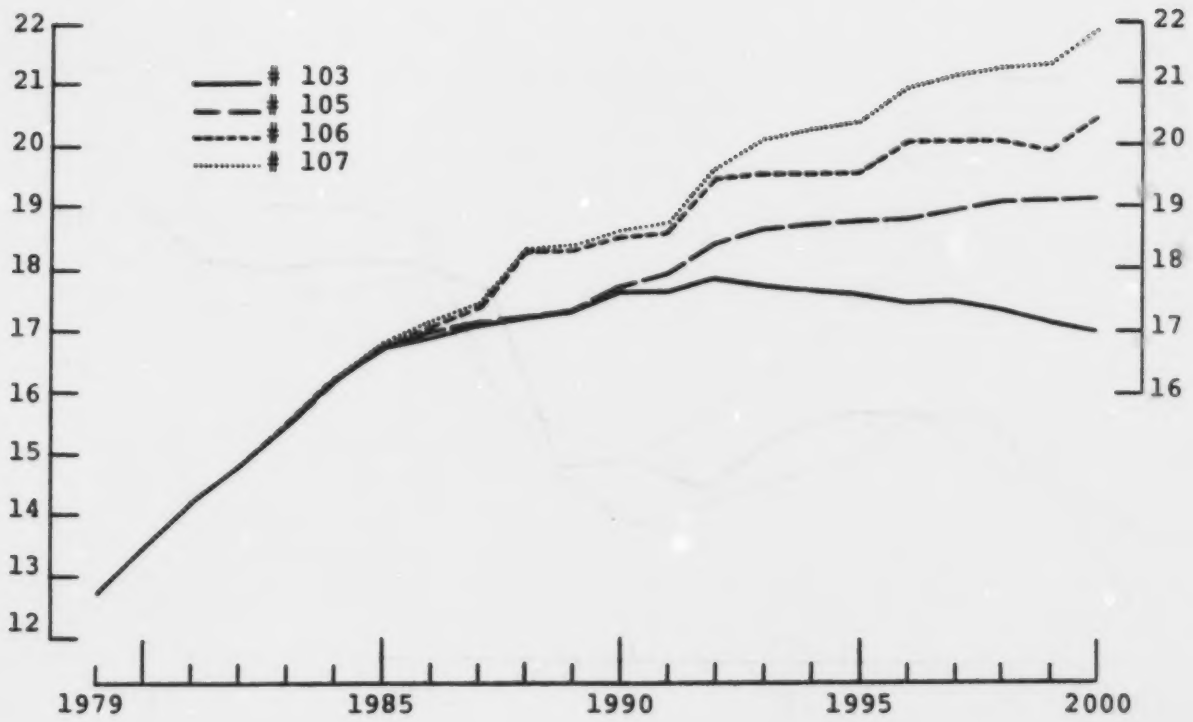


Chart 6-6

Real Labour Income per Employed Person, Alberta

(Thousand 1971$)

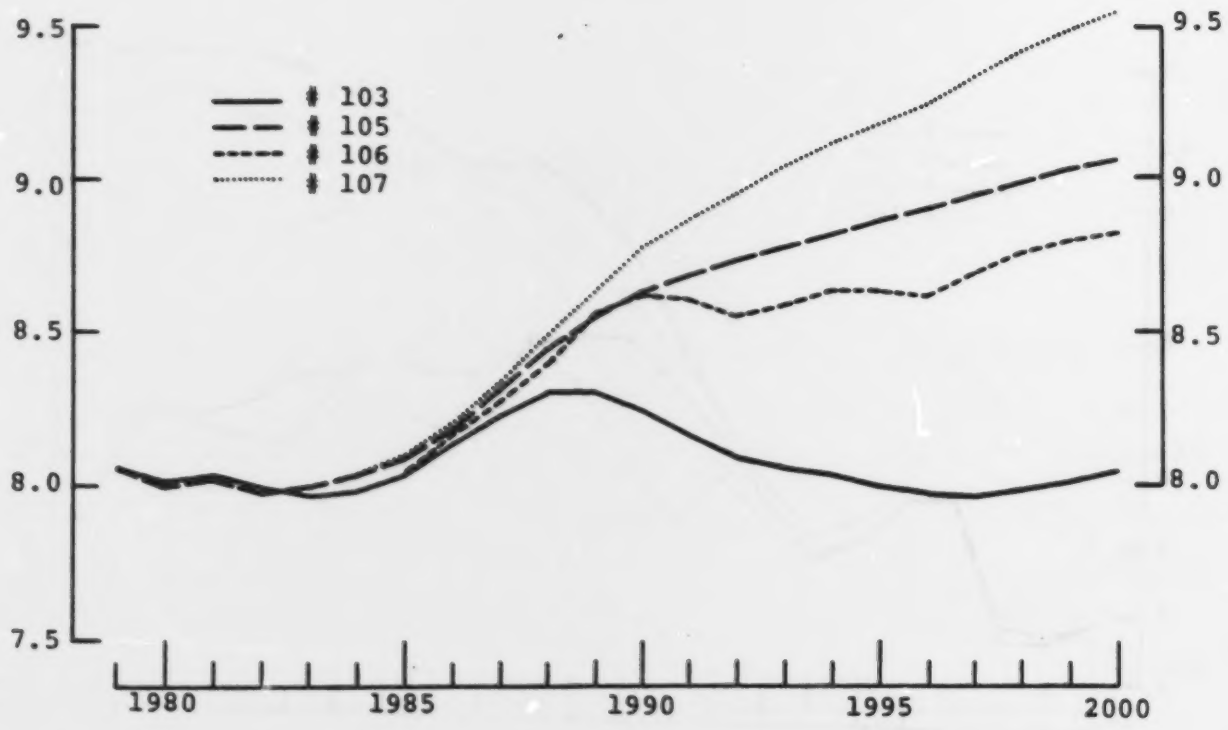


Chart 6-7

Unemployment Rate, Alberta

(per cent)

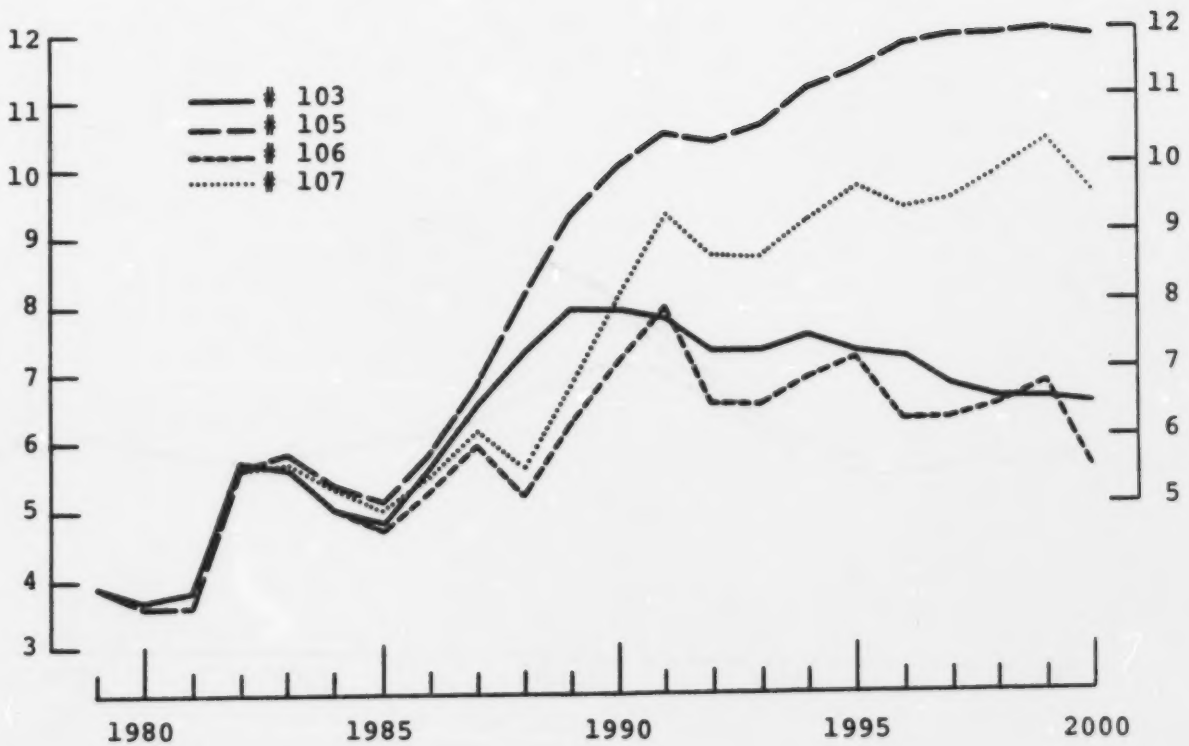
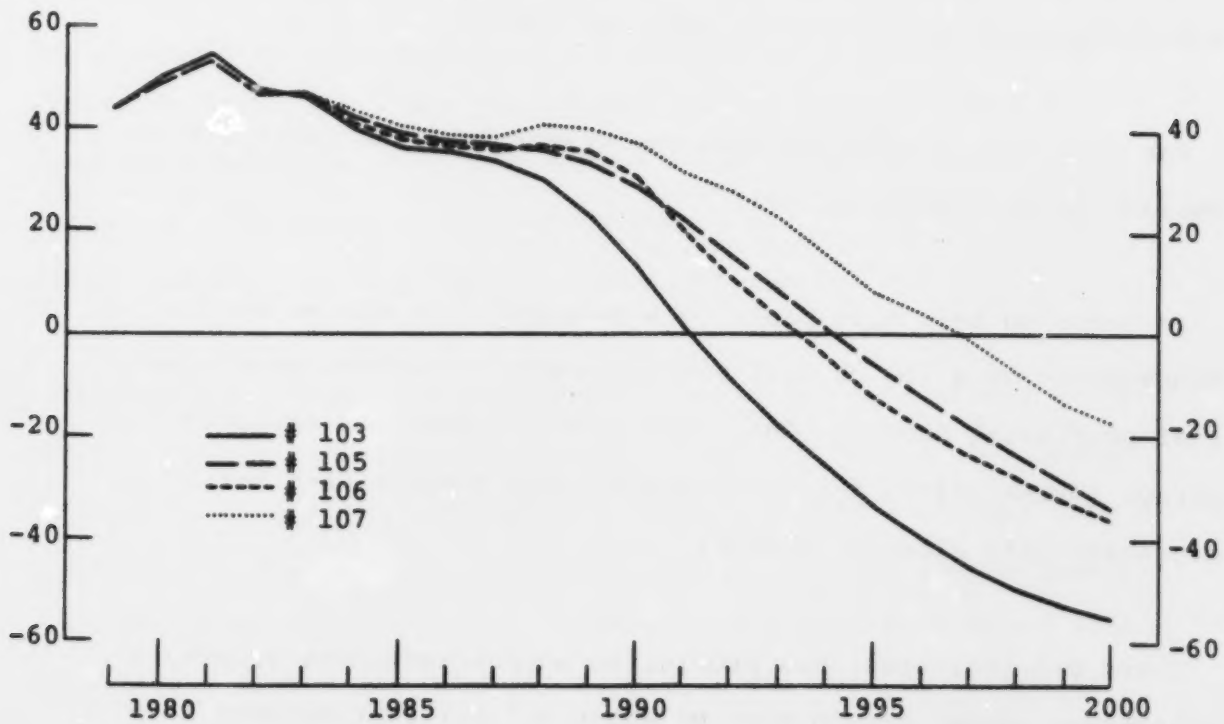


Chart 6-8

Net Migration into Alberta

(Thousand Persons)



with the additional modification that we did not assume in the base case the construction of any further oil sands plants beyond the ones already in existence in 1980; for natural gas, same publication p. 218, supply tracking (but modified so as to allow for somewhat lower gas exports than supply would permit during the first half of the 1980s); for coal the estimate of the Canadian National Committee World Energy Conference, p. 92, and for all other mining output 5 per cent growth per annum. Detailed data and methodology are available from the author.

Our base case simulation uses the linear Phillips curve and is designated as Simulation 103.

In order to keep this paper to a manageable length we shall concentrate on a few crucial macroeconomic variables, namely on real provincial product (XA), real labour income per employed person (WRTAS/CPIA), the unemployment rate (URATEA) and total net migration into Alberta (MIGTNA).

Chart 6-5 indicates that provincial output continues growing at an average annual growth rate of about 4.7 per cent between 1979 and 1985, but the growth rate declines to 1 per cent between 1985 and 1992, followed by a slow decline thereafter. By the year 2000 real provincial product has retreated to the 1987 level. This is a startling result. Over the 1961-1979 period Alberta's growth rate was 6.6 per cent. The reasons for this slowdown bear close examination.

One of the reasons of the slower output growth is, of course, the slower natural growth rate of the labour force source population (1.2 per cent per annum), compared to that of the 1960s and 1970s (2.1 per cent), as the postwar baby boom's delayed effect on the labour force subsides. The decline of the Alberta hydrocarbon output, as the province gradually runs down its conventional oil reserves and also a decline in gas output starting in the mid-1980s has an even bigger restraining effect. Rapid growth of coal mining is not sufficient to counteract the effect of falling oil and gas output, and by the year 2000 this simulation projects Alberta's mining output about 10 per cent below the 1979 level. (During the sample period the provincial mining output increased by 7 per cent per annum.)

Real labour income per employed person (Chart 6-6) offers little ground for cheerfulness either. It hovers around the 1979 level till 1985, then rises somewhat. In the late 1980's it goes into a prolonged decline and its slow recovery in the late 1990's barely restores it to its 1980 level. Calculations show that after 1990 real labour income per employed person in the Rest of Canada is higher that that in Alberta.

The unemployment rate is also worse than in the past (Chart 6-7), though it remains below that of the Rest of Canada until 1994, when the gap closes.

Net migration into Alberta reflects these rather gloomy prognostications for output, real per capita labour income, and unemployment (Chart 6-8). It gradually subsides after 1981, first slowly, then accelerating after 1987, turns negative after 1991 and by 2000 net out-migration from Alberta reaches 56,000 per annum. Total net in-migration in the projection period is 410,061 followed by net out-migration of 327,058 giving a net in-migration of 83,003 for the 1979-2000 period. Note that in this simulation the rising unemployment rate of the 1979-85 period tends to exert a substantial restraining force on the real wage rate, which in turn restrains immigration into Alberta and thus keeps the unemployment rate at the level of the Rest of Canada.

All in all the simulation shows a radically different picture for the future than for the past. Particularly after 1985 growth of output and of real labour income per employed person is drastically down, unemployment rises sharply and after 1990 immigration into Alberta turns into out-migration.

1.b) The situation is markedly different, but not clearly less gloomy if we use the non-linear Phillips curve (simulation 105). Total real output growth is now a little faster. Real labour income per employed person grows a lot more: it is now some $(1971) $1,020 or 12.7 per cent higher in 2000 than in the previous simulation, but this is bought at the price of about 5.5 percentage points more unemployment. The unemployment rate rises sharply after 1985, going well above that of the Rest of

Canada and leveling off around 12 per cent. Immigration into Alberta still declines, though less rapidly than in simulation 103 and turns negative only in 1995. Total net immigration is 497,144, followed by net out-migration of 120,795, giving a net in-migration of 376,349 for 1980-2000.

In sum, the same kind of slow growth problems arise as with the linear Phillips curve, but take different forms. We shall discuss this further below.

2.a) As mentioned in section 1.a of this chapter, the decline of mining output after 1985 is a very important cause of the levelling off and subsequent decline of the Alberta aggregate real provincial product. In our next simulation (simulation 106) we assumed that four additional Syncrude-size oil sand plants were constructed during the projection period. The construction of the plants started in 1983, 1987, 1991 and 1995 and production of crude came on stream in 1988, 1992, 1996 and 2000 respectively. We assumed that each plant employed 3,000 employees more than what the same production of conventional oil would require. We also assumed that the fiscal and financial arrangements were such that no royalties would accrue to government from the production of these oil-sand plants.

Chart 6-5 indicates that in this simulation (106) Alberta's provincial output continues growing -- in a somewhat step-wise fashion -- throughout the projection period, but the steps become

smaller as time progresses. The output growth rate is now 2.3 per cent per annum compared to the 1.4 per cent of simulation 103, but still way below the 1961-1979 average of 6.6 per cent. Unemployment is in general 0.5-2 percentage points lower than in the corresponding simulation without oil-sand plants (Chart 6-7). It is still 5.5 per cent in the year 2000, which is high by Alberta standards. Real labour income per employee (Chart 6-6) gradually increases over that of simulation 103, particularly as the second additional plant construction gets underway and the first one starts producing. By 2000 it stands some $780 (1971) or about 9.7 per cent above the corresponding figure of simulation 103. Even so, net migration into Alberta turns negative after 1992, about 2½ years after it does the same in simulation 103 (Chart 6-8). Total net immigration amounts to 486,723, followed by net emigration of 153,152, yielding in-migration of 333,571 for 1980-2000.

Evidently, the construction of four oil-sand plants mitigates the gloomy outlook of simulation 103, but even this is not sufficient to restore the booming growth of the 1961-1979 period.

2.b) The next simulation (107) assumes, like simulation 106, the construction of four further oil-sand plants, but uses -- as did simulation 105 -- the nonlinear Phillips curve. This simulation shows the highest net immigration into Alberta (Chart 6-8), and partly in consequence also the highest real provincial product (Chart 6-5). The real labour income per employee grows to $9,550 (1971) by 2000 (Chart 6-6), even though unemployment hovers in the

9.5-10.5 per cent range (Chart 6-7). Comparison of simulations 106 and 107 indicates that the 8 per cent gain in real labour income in 2000 has been purchased at the price of 4 percentage points of additional unemployment. A similar trade-off appears in the comparison of simulations 103 and 105.

Net immigration turns negative only by 1997. Total net immigration is 583,265 and total net out-migration 37,894, which gives total net in-migration of 545,371 for the 1980-200 period. Even in simulation 107 there is (a slight) out-migration from Alberta by the end of the 1990s.

Before summarizing our most important findings we wish to repeat some of the crucial assumptions of our simulations.

We have assumed that the world price of hydrocarbons will rise by about 2 per cent per annum in real terms, that the Alberta output of conventional oil and of natural gas will follow the National Energy Board forecast and that the Federal-Alberta accord on hydrocarbon prices and taxes will hold for the rest of this century.

The crucial results of our study are:

Alberta's real provincial product will level off by 1985, in the case of flexible wages it will even turn negative after 1992. Associated with this slow growth is zero growth of per capita real

labour incomes and relatively little net immigration, but unemployment will remain around the national average.

Some of the chracteristics of the results hinge on how flexible wages are. In a specification when they are supposed very flexible (the linear Phillips curve), Alberta's unemployment rate tends towards the level of the national rate in 2000 (i.e., 6.5 per cent) but in that case Alberta's real labour income per employee would be no higher in the year 2000 than it was in 1980. In a less flexible specification (reciprocal Phillips curve) Alberta's unemployment rate levels off around 12 per cent. In this case, the higher wages attract some 290,000 additional migrants to Alberta.

If we assume the construction of four additional oil-sand plants, the outlook becomes somewhat less dark. Real provincial product continues growing but at less than half the 6 per cent plus growth rate of the 1960-80 period. Flexible wages may keep the Alberta unemployment rate slightly below the national one, but inflexible wages would raise it into the neighbourhood of 10 per cent. The impressive increases in real labour income per employee which occurred during the 1960-80 period are things of the past and will not recur. Net migration into Alberta will gradually subside in the 1990s and turn into out-migration, though the latter could be relatively modest if the oil-sand plant constructions proceed and wages are inflexible.

Our results emphasize the importance of some old questions of classical economics: does the flexibility of wages mitigate unemployment and if so, to what extent; and what is the degree of such flexibility in the Alberta economy? The first question is answered by our preceding simulations: additional real wage increases of 8-13 per cent yielded by flexible real wage behaviour increase unemployment by 4-5.5 percentage points. On the second question, one would usually check this by how well each specification did in the estimated equation. However, recall that the test-statistics of the flexible (linear) wage equation and that of the rigid (non-linear) one (reported in Chapter 5) were about equally good when evaluated as single equations. In the following section we report the results of the sample period full system simulations, using the alternative wage equations. In order to gain some information about the actual real wage flexibility in the Alberta economy we performed full system simulations over the sample period, using the alternative wage equations.

B. Sample Period

In order to explore the ability of the model to reproduce the sample period behaviour of the Alberta economy we have run a simulation over the 1965-79 period using the system's own calculated values as lagged variables.

1) In Charts 6-1 to 6-4 the solid lines represent the actual historical data. The line with long dashes (simulation 102)

represents a full system dynamic simulation using that variant of the wage-equation which contains the unemployment terms in linear form, the "more flexible" wage equation. Chart 6-1 indicates that this model version tends to overestimate real output during the 1970-76 period and underestimate it thereafter. The simulated real labour income per employed person (Chart 6-2) reproduces the general shape of the actual events, but consistently underestimates after 1970. Chart 6-3 indicates that the simulation tends to exaggerate the fluctuations of the actual unemployment rate. The same holds true of net migration into Alberta (Chart 6-4).

2) We have also performed the sample period simulation using the wage-equation with the unemployment rate in the "wage inflexible" or reciprocal form (simulation 101). In this version of the wage-equation the wage rate is very sensitive to low unemployment rates, but insensitive to high rates. In the 1965-67 period Alberta's unemployment rate hovered in the 2.5 - 2.7 per cent region. Unfortunately, in 1966 our output equations happened to overestimate construction -- and service -- output (Chart 6-1) and this depressed the calculated unemployment rate well below the actual (Chart 6-3). The low unemployment rate leads in the case of the wage-equation using the reciprocal unemployment rate to a very high wage rate in the next year (Chart 6-2), which in turn leads to very high immigration (Chart 6-4). The high immigration tends to keep unemployment rates high in the subsequent years, but in the case of the nonlinear wage-equation the wage remains

relatively high, inducing further high immigration. Only by 1973 do the simulated wage, unemployment rate, and net immigration values return to the actual values.

3) We have performed an additional simulation over the sample period. This was identical with the previous simulation using the nonlinear Phillips curve (i.e., simulation 101) except for the following change: in the year 1966 we adjusted the construction -- and service -- industry outputs by their single-equation estimation error (i.e., by -34.531 million and -35.302 million respectively). The result is charted as simulation 108. Inspection of Charts 6-1 to 6-4 shows that the performance of simulation 108 is very similar to that of simulation 102 which used the linear Phillips curve.

This experiment indicates that our model results are extremely sensitive to wage behaviour under very low or very high unemployment rates.

We can summarize the error statistics of our sample period simulations as shown in Table 6-1.

The results suggest that there is little to choose between simulations 102 and 108. Simulation 101 is much inferior to 102, but an output correction of $70 million (1971) in the year 1966 improves the performance dramatically.

We must conclude that the historical data are not capable of deciding the degree of flexibility of Alberta wages on the basis of sample period simulation. All it can do is to emphasize the importance of the flexibility for Alberta during the rest of this century.

Table 6.1

Dynamic 1965-79 Simulation with

	Linear Phillips Curve (Simulation 102)		Non-linear Phillips Curve			
			No Adjustment (Simulation 101)		Adjustment in 1966 (Simulation 108)	
	Mean Absolute Error	Standard Deviation of Error	Mean Absolute Error	Standard Deviation of Error	Mean Absolute Error	Standard Deviation of Error
Real Provincial Product (Mean = 8312.3)	172.0	133.9	392.5	268.9	146.0	95.1
Real Labour Income per Employed Person (Mean = 6.852)	0.161	0.102	0.304	0.208	0.132	0.092
Unemployment Rate (Mean = 0.0404)	0.0113	0.00733	0.0185	0.0159	0.111	0.00696
Net Migration (Mean = 20,246.1)	6327.1	4694.1	7926.5	6287.6	7164.7	5609.3

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